



Climate of Lucknow

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PREFACE

Weather and climate is associated with every aspect of our day to day life. It has affected over human beings, animals, birds, insects, flora and fauna. It affects our lives socially, economically, medically etc. Apart from general weather information provided by India Meteorological Department, the general public, decision makers and media have become conscious about the climate and the extreme weather conditions of a place. This book deals with the climate of Lucknow. A Meteorological Observatory in Lucknow was established during the British period on October 6, 1894 within the city. Later on the observatory was shifted in the Amausi area (Krishna Nagar) on February 1, 1948 and finally shifted to Amausi airport (Chaudhari Charan Singh airport) on 29 November, 1972. Daily meteorological data of this observatory has been utilized to arrive at the climatology of Lucknow where as daily meteorological data of the observatory functioning since beginning is used to find the extreme events.

The book contains monthly summaries of four seasons and also the annual summaries. In each season the averages and extremes of temperatures, humidity, rainfall and wind have been included. The probability of occurrence of various weather phenomena are also described in detail which is very essential for planning for disaster and its mitigation. At the same time weather conditions on national holidays viz. Republic Day, Independence Day, Gandhi Jayanti have also been discussed in the book.

We are also thankful to National Data Centre Pune, Technical Section of M. C. Lucknow specially Sh. Moti Lal, Sh. Bachcha Singh, Mrs. Ritu Bose, Mrs. A. V. Sharma and Sh. R. P. Kuril, Mrs. Kalpana Shrivastava, Sh. Sanjeev Chauhan for providing data on the subject.

Lucknow

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19 January, 2012

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Geographical Setting of Lucknow

Lucknow, the capital of Uttar Pradesh is situated 123 mts above sea level. It is situated on 26.30 & 27.10 North latitude and 80.30 & 81.13 East longitude. Lucknow covers an area of 3,244 sq.km. It is surrounded on the eastern side by District Barabanki, on the western side by district Unnao, on the southern side by Raebareli and on the northern side by Sitapur and Hardoi districts.

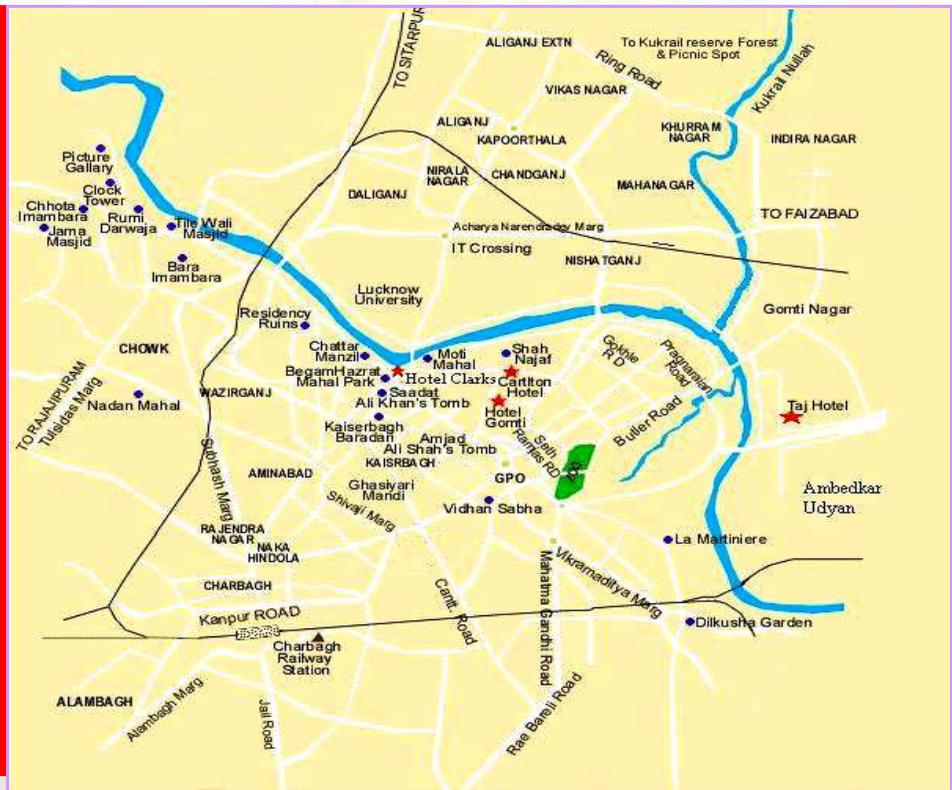


Fig. 1. City map of Lucknow

Physiographic and cultural setting of Lucknow

River Gomti flows through the city. Some of the tributaries of this river are Kukrail, Loni, Beta etc. Sai river flows from the south of the city and in the east enters district Raebareli. Lucknow is accessible from every part of India through Air, Rail and Road. It is directly connected with New Delhi, Patna, Calcutta, Mumbai, Varanasi and other major cities by Chaudhari Charan Singh airport. Similarly city is linked to north, east, south and west through rail and road links. The population of district Lucknow as per census 2001 is 36,81,416 lacs.

Lucknow is the capital of Uttar Pradesh, a multicultural city. Historically it is known as the Awadh. Famous for Courtly Manners (Tahzeeb), Beautiful Gardens, Qauwwali, Chikankari Embroidery, Kabobs, Poetry, Music, and Fine Cuisine patronized by the Nawabs. Lucknow is popularly known as the The City of Nawabs. It is also known as the Golden City of the East, Shiraz-i-Hind and The Constantinople of India.

Today, Lucknow is among the top ten fastest growing non-metropolitan cities of India. Lucknow also an emerging hub for producers of goods and services with very promising potential. Lucknow has been a mandi town of mangoes, melons, and grains grown in the surrounding areas. Sugarcane-growing plantations and sugar industries are also in close proximity. This attracted Mohan Meakin Brewery to set up a unit based on molasses in the city. Meakins was incorporated in 1855 and is Asia's first commercial brewery.

General Climate of Lucknow

Lucknow-The capital of Uttar Pradesh is a land locked city. The distance from the sea gives Lucknow an extreme type of continental climate with the prevalence of continental air during major parts of the year. Only during the four months from June to September does the air of oceanic origin penetrate to this region and causes increased humidity, cloudiness and rain. About 75 % of the total rainfall is realized during these four months. The year can be broadly divided in to four seasons. The cold season starts from December and extends up to end of February. This is followed by the hot weather season which lasts till about first fortnight of June when monsoon arrives over the region. The monsoon continue till September. The two post monsoon months of October and November constitute a transition season from monsoon to winter conditions.

The summers in Lucknow are very hot and winters very cold. The temperature may rise up to about 46 degree Celsius in summers, though the average temeperature is around 38-39 degree Celsius. There are about 4-6 days of heat wave when the maximum temperature of a day rises to 4-6 Celsius above normal values. Though the winters are not bitterly cold on most of the days, the temperature may fall to 3-4 degree Celsius for a few days in winters when the cold winds from the Himalayan region makes the winters chilly. The winters are also marked by mist and fog in the mornings. However, the Sun is often seen in the afternoons.

Data Used

A Meteorological Observatory in Lucknow was established during British period on October 6, 1894 within the city. Later on the observatory was shifted in Amausi area (Krishna Nagar) on February 1, 1948 and finally shifted to Amausi airport (Chaudhari Charan Singh airport) on 29 November, 1972. Daily meteorological data of this observatory has been utilized to arrive at the climatology of Lucknow where as daily meteorological data of observatory functioning since beginning is used to find the extreme events The climatology of rainfall, temperature, humidity and wind described in the following sections are based on 30 years period of 1971-2000. The extremes of temperature and rainfall described are from the year 1901 to 2010. The data of weather phenomena are for a 30 years period of 1981 to 2010.

The annual march of maximum/minimum temperatures and rainfall is given in Fig. 2. It shows that temperature are at their peak during the months of May and June. Though the temperature start falling in the month of July, the fall is gradual till October. The maximum temperature decreases sharply from the month October and the minimum temperature decreases sharply from the month of September with January being the coldest month. The normal rainfall increases from the month of June with the onset of pre-monsoon rainfall activity in the first fortnight and the onset of South West monsoon in the second fortnight of the month. July and August are the rainiest months however good amount of rainfall occurred in the month of September while retreating the monsoon. Monsoon withdraws towards the end of September. The rainfall decreases drastically from the month of October. April is the driest month of the year.

Monthly means/extremes of temperatures, number of days with heat wave/cold wave, monthly total/ extreme rainfall and the average number of days with different weather phenomena are given in Table 1, 2, 3, and 4 respectively.

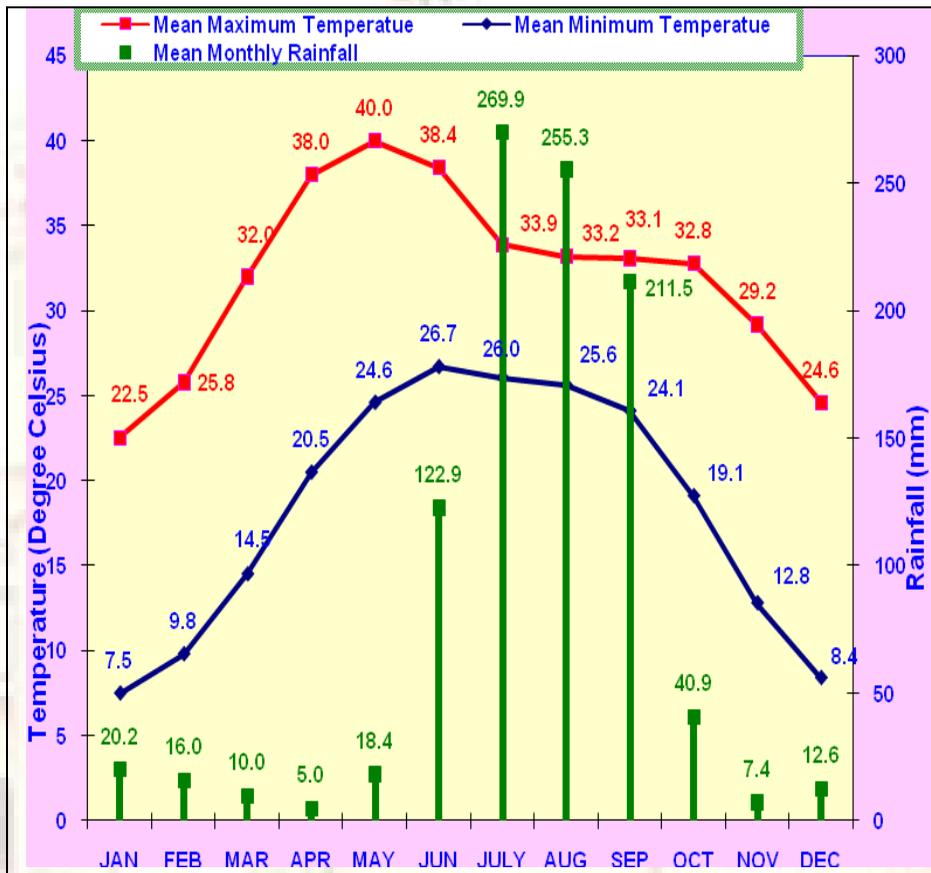


Fig. 2. Monthly Normal Maximum & Minimum Temperatures and total Rainfall

Winter season

The winter season in Lucknow starts in the month of December and lasts up to February. Likewise the country Uttar Pradesh also Celebrates Republic Day during the season on 26 January the date on which constitution of India came in to force in 1950. Magnificent Republic Day Parade takes places From K. D. Singh Babu Stadium to Ravindralaya (Charbagh). Main functions are organized at Vidhan Sabha where The Governor who is the head of the state takes the salute of Armed forces, State Police Forces, different wings of N.C.C. etc. Tableaus of various organization spreading the message are also the part of attraction. Christmas and New Year celebrations are the other main attractions of the Season.

Though the winters are not bitterly cold on most of the days, the temperature may fall to 3-4 degree Celsius on few days in the season when cold winds from Himalayas prevails over the region making the winter chilly. The winters are also marked by mist and fog during night and in the mornings. Though the Sun is often out in the afternoons on most of the days, fog lasting for many hours in the day is not uncommon during 15 December to 20 January.

Temperatures

The daily normal maximum and minimum temperatures for the season are given in fig. 3 below. The maximum temperatures register a gradual fall through the month of December. They fall from about 26 Deg. C in the beginning of the month to about 22 Deg. C towards the end. They continue to remain around 22 Deg. C till the third week of January and then start rising, reaching to about 24 Deg. C till the end of the month . They continue to rise through the month of February and reach to about 28 Deg. C by the end of the season.

The minimum temperatures also have a similar march through the season falling from about 10 Deg C in the beginning of December to about 7 Deg. C by the end of the month. They remain around that value till third week of January. The upward trend continues thereafter throughout the month of February. The minimum temperatures reach to about 11 Deg C by end of the season.

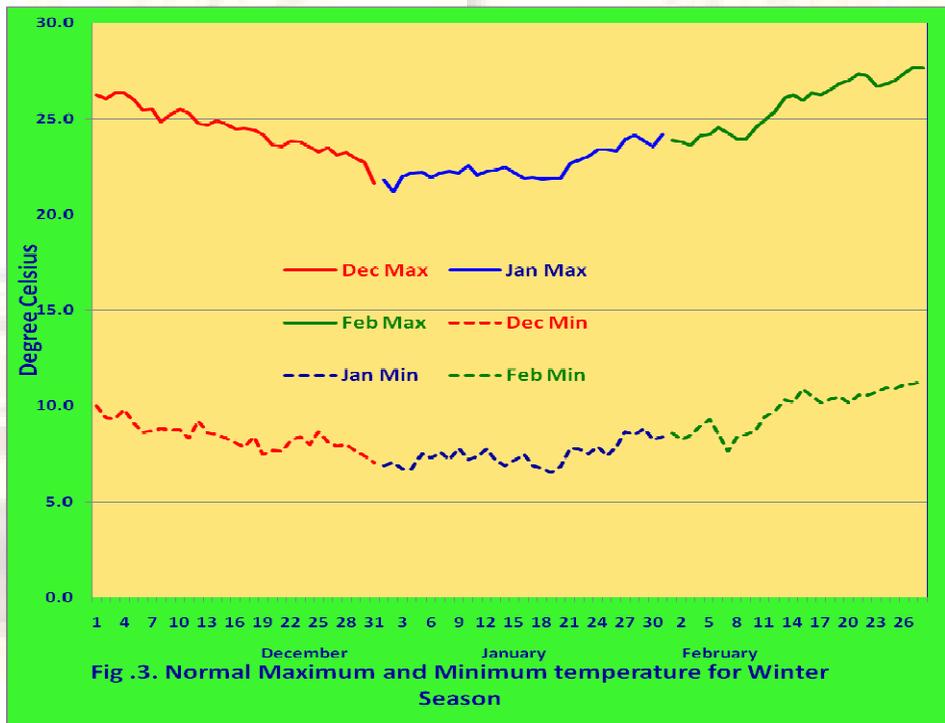


Fig .3. Normal Maximum and Minimum temperature for Winter Season

Diurnal Variation of Temperature

The day temperatures show a diurnal variation of about 10 to 12 degree C during the season. Figure 4 shows the diurnal variation of temperature over Lucknow during the first and second fortnights of December, January and February. Lowest temperatures are recorded around 07 hours IST during the season. A steep rise is experienced from 0800 hours IST to 1200 hours IST. However they continue to rise till 1600 hrs IST. The temperatures are lower by about 3 to 5 degrees at all hours of the day during the coldest month of January than those recorded in the second fortnight of February

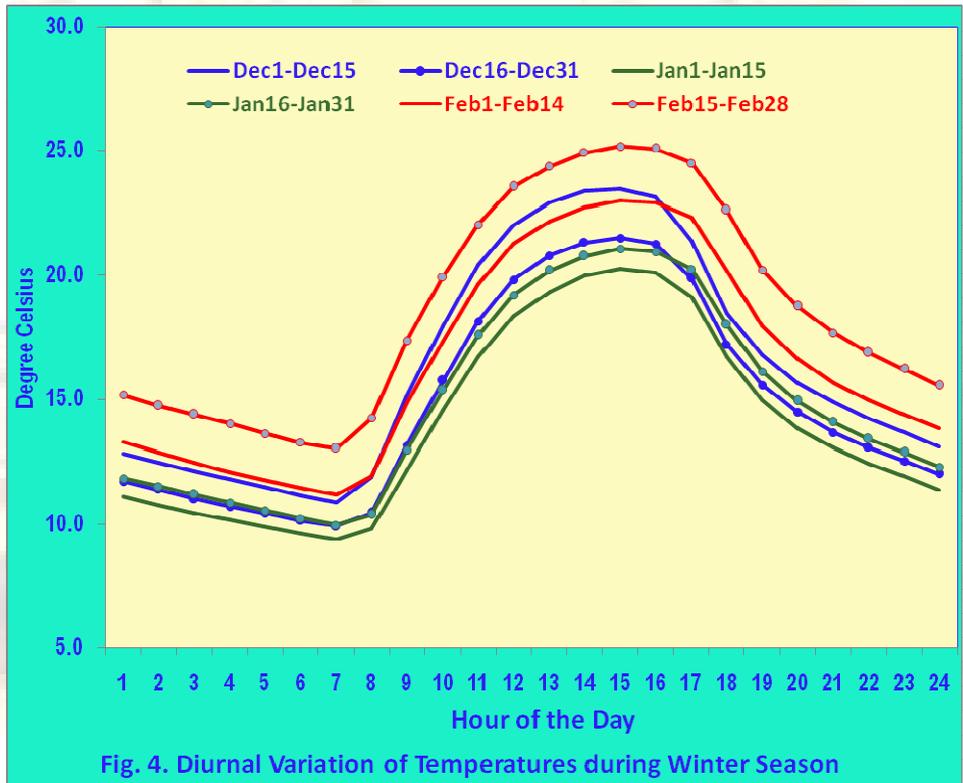


Fig. 4. Diurnal Variation of Temperatures during Winter Season

Extreme Temperatures

The highest and lowest maximum temperatures recorded during the season (1971-2010) given below show that maximum temperatures can have quite a large range during the season. The highest maximum temperatures in the month of December range around 26 to 29 Deg C during most of the years. They range around 25 to 30 Deg C during January and 30 Deg. C to 35 deg C during February. The highest maximum temperatures recorded during the period are 29.9 Deg C for December(4 December, 1976), 31.6 Deg. C for January (4 January, 1992) and 35.9 Deg C for February (25 February, 2006). The lowest maximum temperatures recorded in the city for different months during the season are 11.0 Deg. C for December (2 December, 2003) 10.2 Deg. C for January (17 January, 2003) and 14.5 Deg. C or February (1 February, 1982).

The maximum temperatures on certain days remain very much below normal due to persistent fog and cold winds leading to cold day conditions (when maximum temperature is 16° C or below). Foggy conditions prevail during winter for several days or weeks leading to above normal minimum temperatures and below normal maximum temperatures. The average number of cold days in 0.55 for December, 2.0 for January and negligible (0.05) for February. However, there is large inter-annual variation. The highest number of cold days were 6 for December (1997) and 19 days for January (2003).

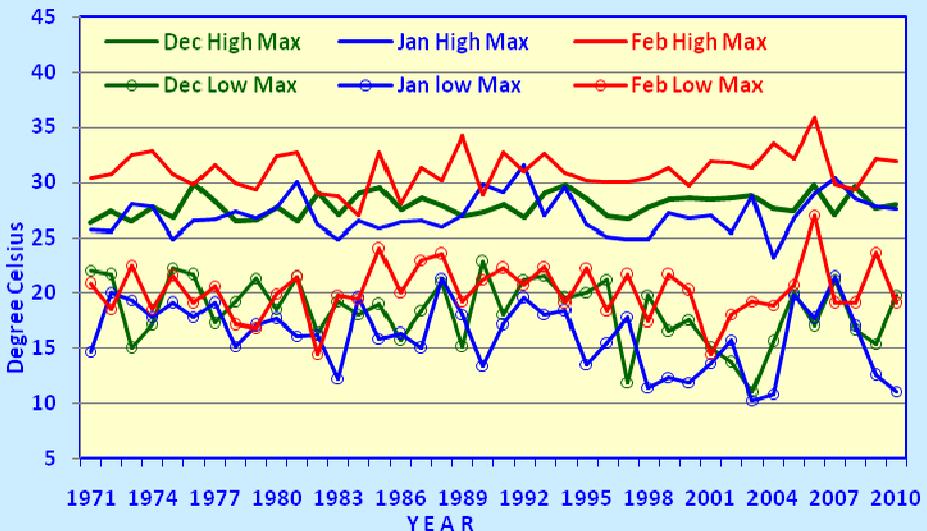
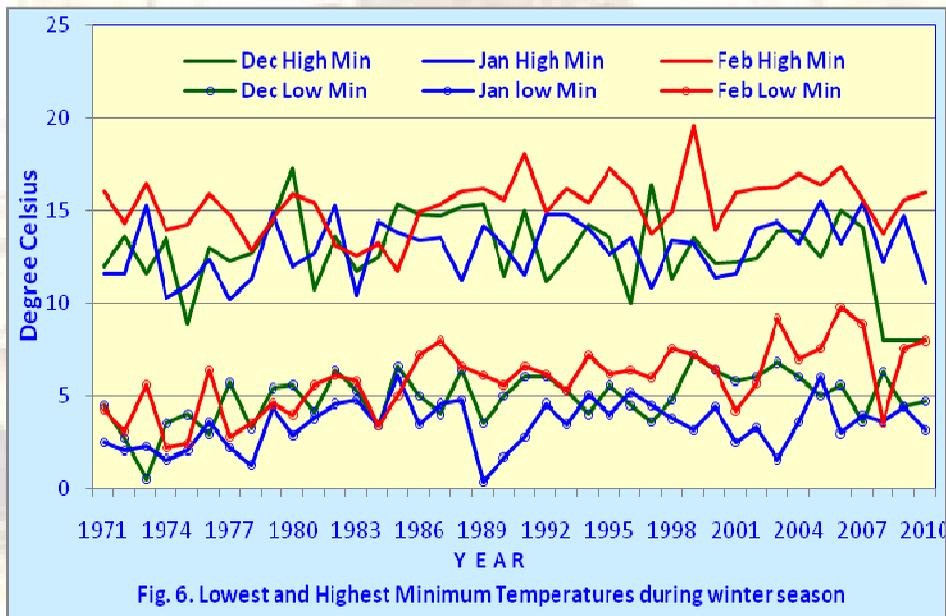


Fig. 5. Highest and Lowest Maximum temperature during winter season

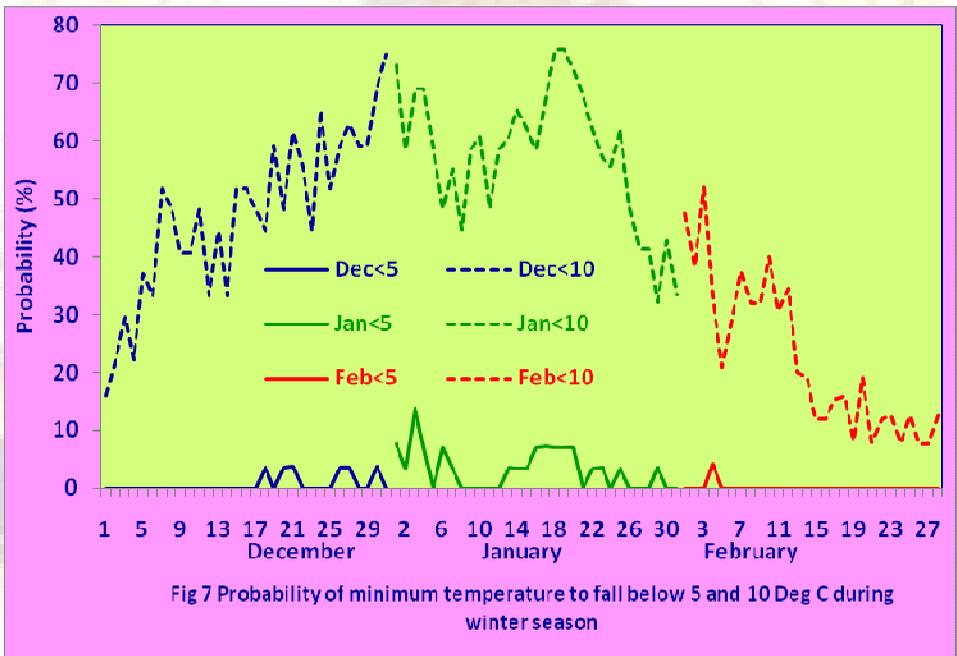
During most of the years, The lowest minimum temperatures recorded are around 4-6 Deg . C during December , around 3-5 Deg . C during January and around 6-8 Deg C during February (Fig .6.). However, quite low temperatures have been recorded in some of the years for all three months. The all time record for lowest minimum temperature during the season are 0.5 Deg. C on December 31, 1973, -1.0 Deg. C on 31st January 1964, 0.0 Deg. C in 2nd February, 1964.

Such low temperatures are recorded when cold northerly winds from the frigid Eurasian land mass set in over the area after the passage of a western disturbance across northern parts of the country. The minimum temperatures can be quite high (14 to 16 Deg C) on an individual days during the season, particularly ahead of an approaching western disturbance, when moist air from south penetrates into the region and nights are cloudy allowing little nocturnal cooling. The highest minimum temperatures recorded in the city for various months during the season are 17.3 Deg. C on 25 December, 1980, 15.5 Deg. C in 31 January, 2005, 19.6 in 25 February, 1999.



The rise in temperature on the approach of western disturbances is a relatively slow process whereas the fall is steeper as they move away. These rise/fall are because of the change in the air mass on approach and in the rear of these disturbances. The highest fall in the maximum and minimum temperature are given in table 5. The maximum temperature recorded on 02 January 1992 was 11.5 °C lower than that of previous day. Also the night of 14 February 1972 was 9.2°C cooler than that of 13 February 1972.

The probability of minimum temperatures to fall below 5 and 10 Deg. Given in Fig. 7. Show very high probability (60%) of minimum temperatures to fall below 10 deg. C from third week of December to third week of January it goes down to below 35% from middle of February. The probability of minimum temperatures to fall below 5 deg. C is around less than 5% from in the second fortnight of December and its probability is maximum in first and the third week of January. It is negligible till 15 December in the beginning and in the month of February.



Humidity

The daily mean maximum and minimum relative Humidity (RH) given in Fig. 8 show that the maximum RH remains quite high all through the season due to relatively low temperatures. maximum relative humidity is more than 90% during December, January and in first fortnight of February and it gradually decreases up to 85 % at the end of season due to gradual warming in the second half of February. The Minimum temperature gradually increases from 35% as the season advances and become highest around 50% in the last week of December and in the first fortnight of January and gradually decreases up to the end of the season and reaches nearly 30%.

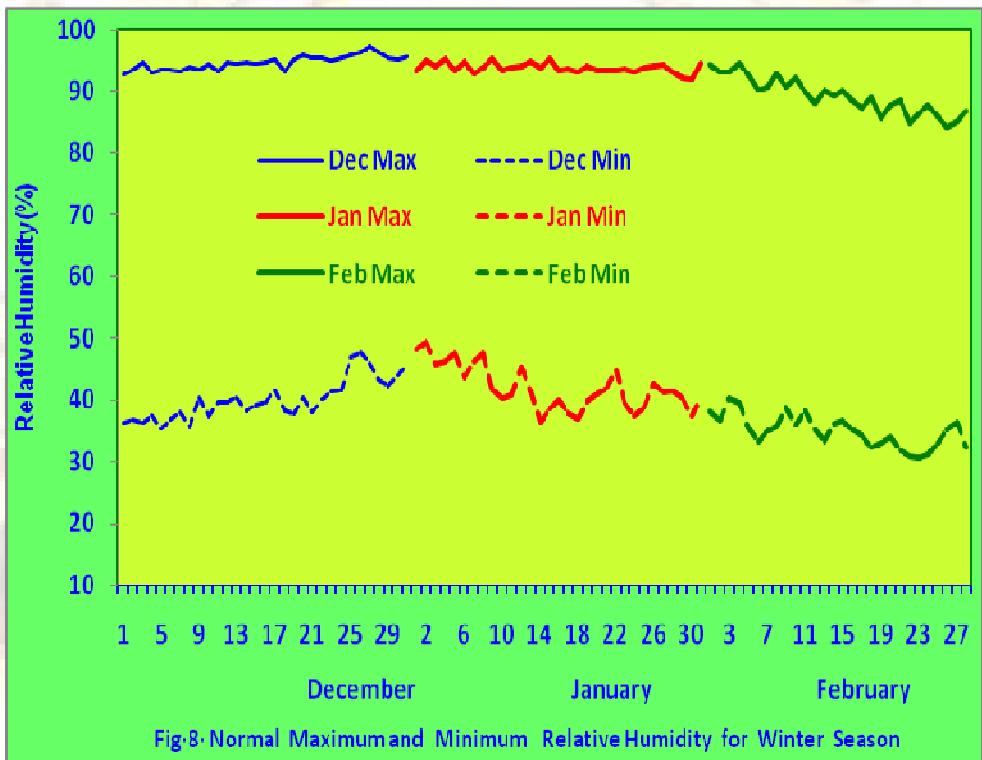


Fig.8- Normal Maximum and Minimum Relative Humidity for Winter Season

Diurnal Variation of Relative Humidity

The diurnal variation of RH (Fig. 9) shows that the highest RH of about 85-90 % is recorded at 0800 hrs IST during most of the season except for second fortnight of February when the maximum RH of about 80% is recorded at 0700 hrs IST. It shows a sharp decline from 0800 to 1300 hrs IST with a gradual fall afterwards till 1600 hrs IST. It then registers a sharp increase reaching to 2200 hours in the night during most of the season except in February when it reaches up to 70-75%. The RH is highest during second half of December and first half of January at all hours of the day and the lowest in the second half of February.

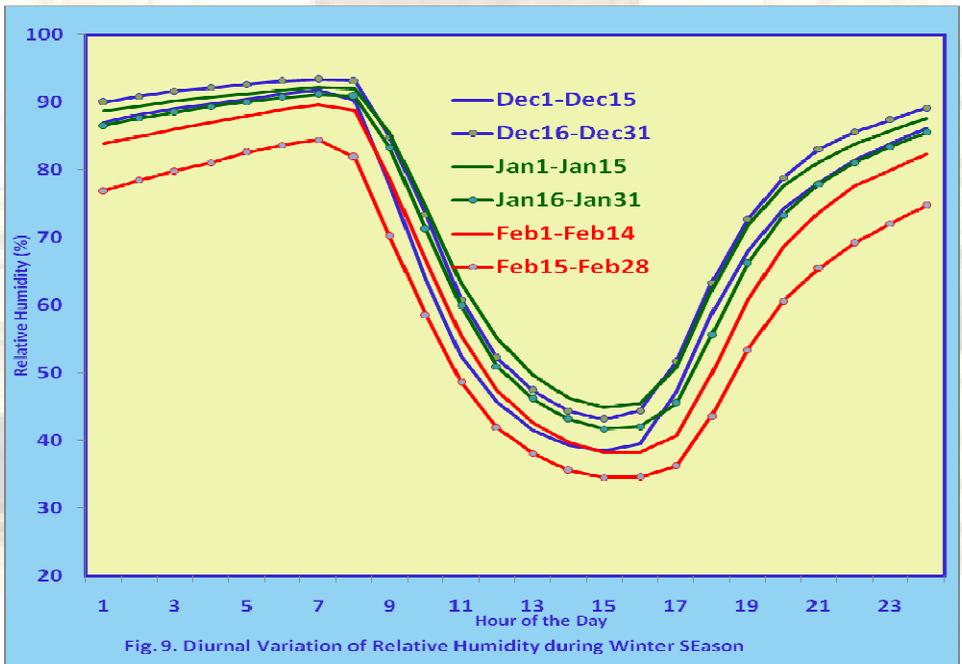
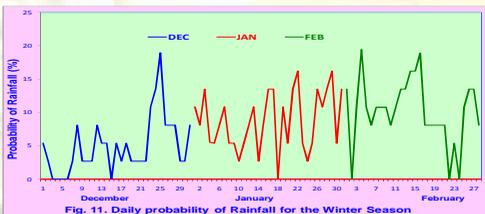
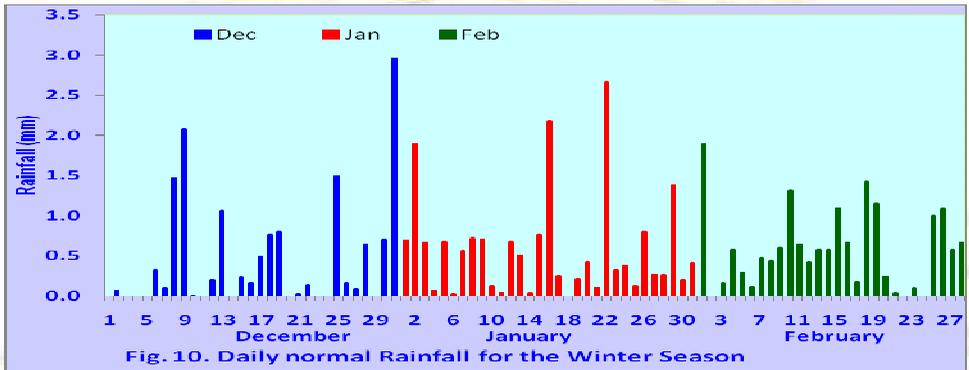


Fig. 9. Diurnal Variation of Relative Humidity during Winter Season

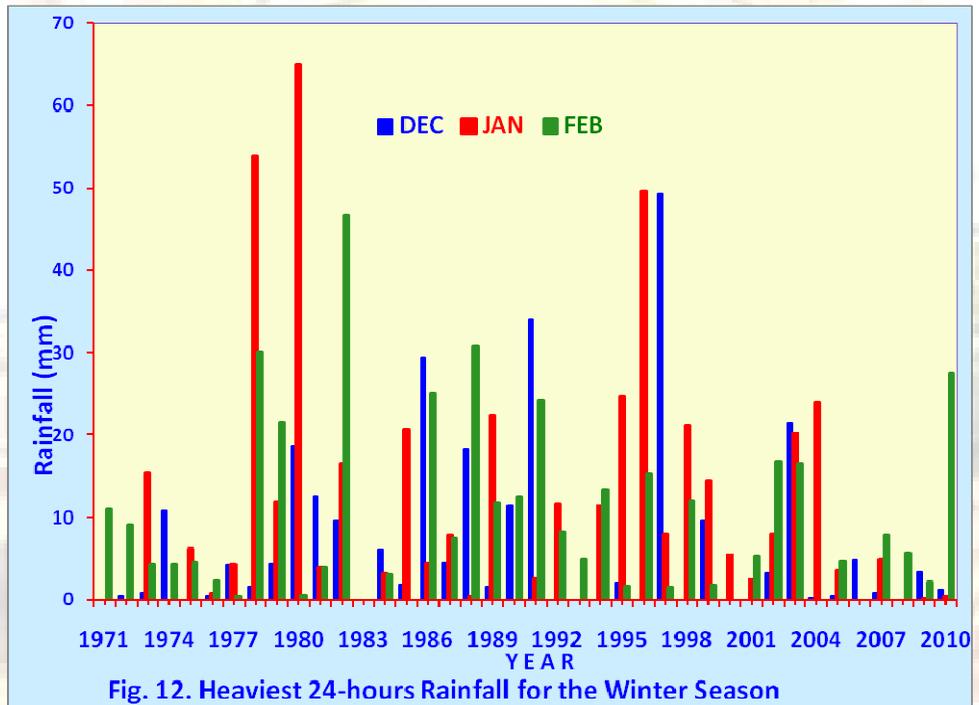
Rainfall

Winter is not a rainy season for Lucknow. However, the season is not completely devoid of rainfall activity. Rainfall Occurs in the association with eastward moving mid-latitude weather system (Known as Western Disturbances). Mean monthly rainfall is 12.6 mm, 20.2 mm and 16.0 mm for the month of December, January & February, respectively. The daily normal rainfall for each day (Fig. 10) shows that that the rainfall activity is more in January as compare to other two months. The average number of rainy days in the of December, January and February are 0.8, 1.5 and 1.5, respectively. The probability of rainfall for each day in the season (Fig.11) shows that the probability of rain during winter season increases from less the month than 10% in the beginning of December to 15-20% in the end of the month. It fluctuates throughout the season mostly in between 5-20% and never exceed 20% within the season.



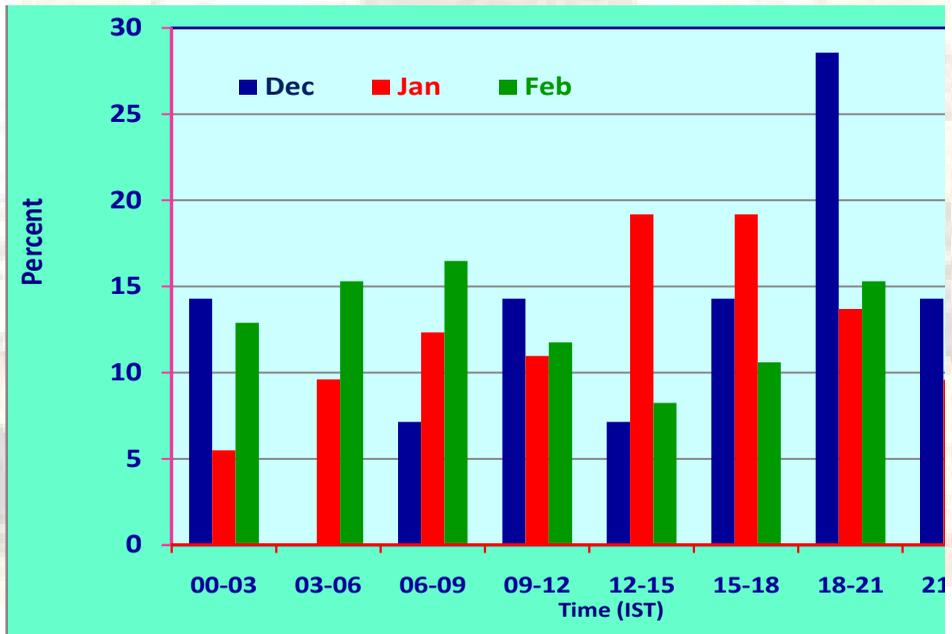
Heavy Rains

Heavy rains are normally not experienced during winter season except one or two cases when exceptionally heavy rainfall recorded at the station. The heaviest 24 hours rainfall of winter months (1971-2010) in Figure 12 shows that 2-3 cm in 24 hours is not uncommon during the Season. The Heaviest rainfall (1971-2010) in 24 hours for the months of December, January and February are 46.2 mm (9 December, 1997), 65.0 mm (2 January, 1980), 46.7 mm (1 February, 1982), respectively.



Thunderstorm and other weather phenomena

Thunderstorm activity is not very high during the season with an average of only 0.6, 0.9 and 2.2 days of thunderstorm during December, January and February respectively. However there is large inter-annual variation in number of days with thunderstorm ranging from zero during many years to maximum of 3 In December (1991), 7 in January (1983 & 1999) and 6 In February (1990 & 2005). The diurnal variation of thunderstorms (Figure 13) shows that the most preferred time is from 1800-2100 hrs in the month of December, during which more than 29% thunderstorms occurred , 1200-1800 in the month of January occurring more than 38% thunderstorms during the period and from 0300 to 0900 hrs in the month of February occurring 32% thunderstorms during the period. Other phenomena, except for fog, are not very common during the season (Table. 4)



Wind

Winter is not a windy season for Lucknow. The average wind speed is 4 to 7 kmph from 1800 hrs IST in the evening till 0800 hrs IST in the morning. As the sun rises, wind speed starts rising from 0900 hrs IST and reach the peak around 1400 to 1500 hours in the afternoon. The wind speeds drop sharply from 1500 to 1800 hrs. There is a general increase in wind speed as the season progresses. The mean monthly wind roses for morning (0830 IST) and evening (1730 IST) given in Fig 15 show that the most prominent wind direction during the season is west to west-northwest. In the evening (1200 Hrs IST) the winds are prominently west-northwest in December, west in January and west-northwest to north westerly in February. The winds exhibit an anticlockwise shift from December to February.

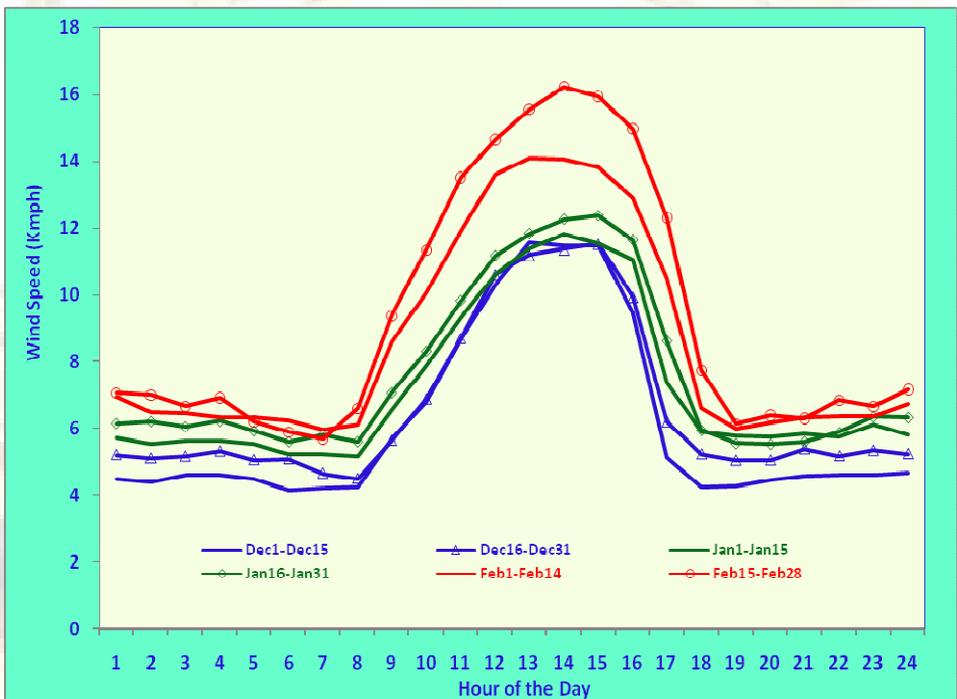
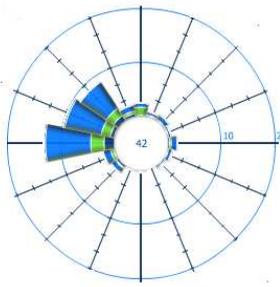
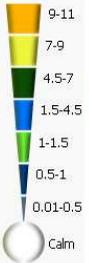
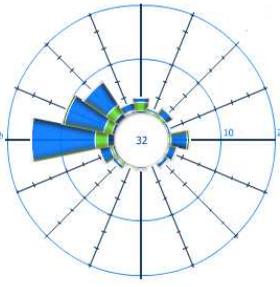


Figure 14. Diurnal Variation of wind speed during Winter Season

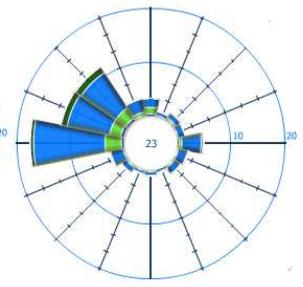
m/s



December

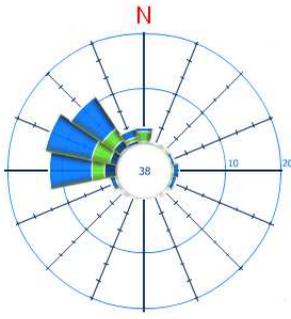


January

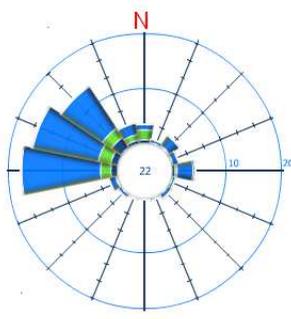


February

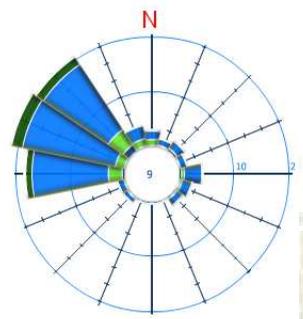
Morning



December



January
(Evening)



February

Fig-15. Wind roses for the Winter Season



Though the average peak wind speed is 12-14 Kmph during most of the season except in the month of December when average peak wind speed is less than 10 Kmph. The wind speed around noon hours exceed 10 kmph or more than 52, 53 and 66 % of the days during the months of December, January and February respectively (Fig. 16).

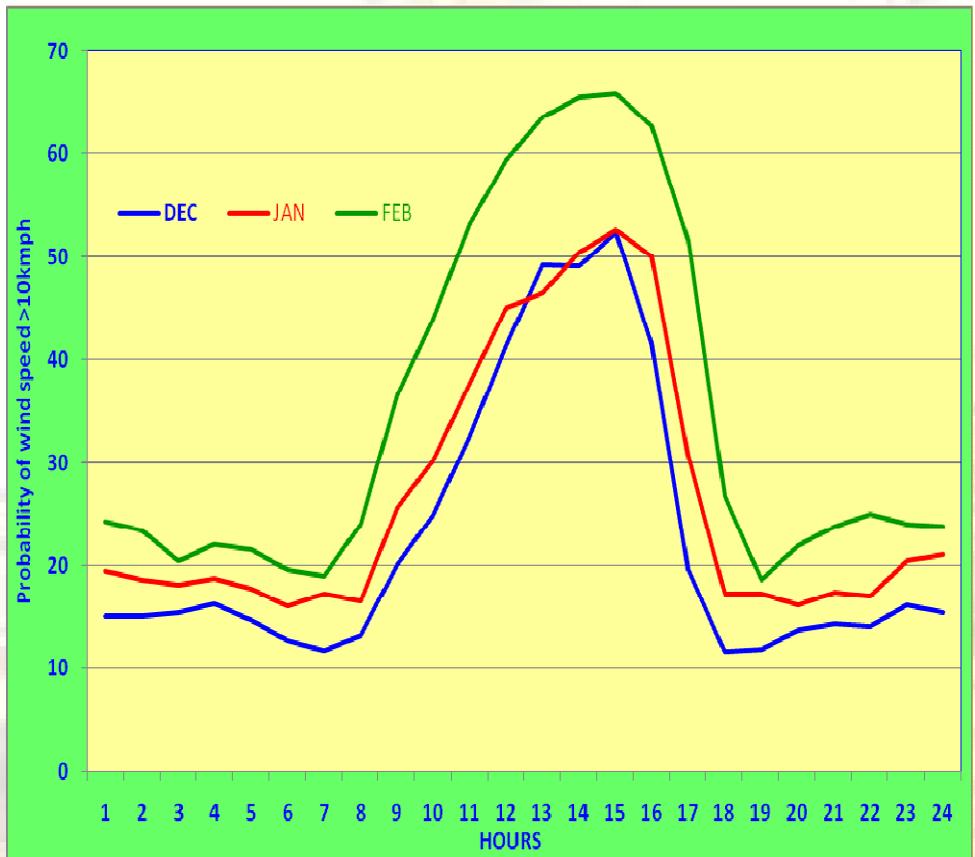


Figure 16. Probability of wind speed to exceed 10 kmph during Winter Season

Summer Season

The months of March, April and May constitute the summer season. The season is characterized by dry and hot weather in Lucknow. Increasing insolation and rise in temperatures with high incidence of convective weather phenomena (dust storms thunderstorms hailstorms and squalls) are the main weather features of the season. Any incursion of moisture and/or operation of and trigger mechanism create condition conducive for explosive convective phenomena high day temperatures with heat waves are the main features of the season. Dust storms, often referred to as “Andhi” are common during the season.

Daily Temperatures.

Continuous increase in temperatures is the main feature of the season. The daily normal temperatures for the season are given in Figure 17 below. The maximum temperatures register a sharp increase from about 28 Deg. C in the beginning of March to about 40 Deg. C by April end. They maintain around 40 to 41 Deg. C throughout the month of May. The minimum temperatures also indicate a similar increasing trend from about 12 Deg. C in the beginning of March to about 26 Deg. C by the end of May.

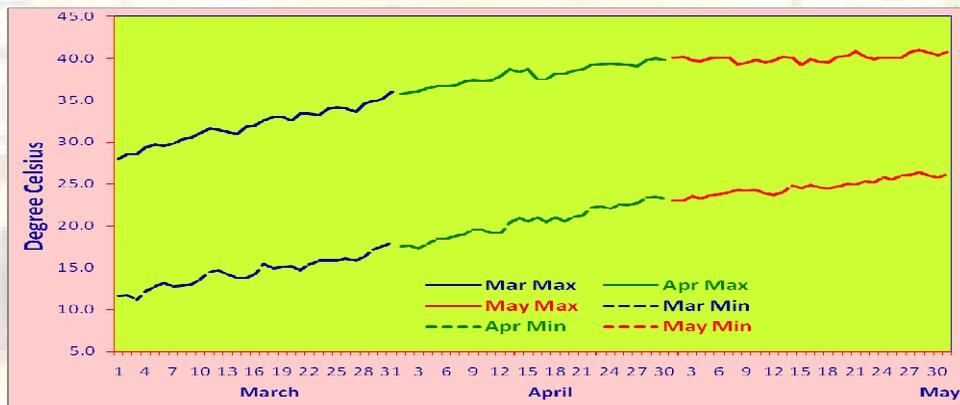


Figure 17. Normal Maximum and Minimum temperature for Summer Season

Diurnal Variation of Temperature

The lowest temperatures during the day are recorded around 0700 hours IST in March; and around 0600 hours IST in April and May as the Sun starts rising earlier. The temperatures increase sharply from 0800 to 1300 hrs IST (12 to 13 Deg. C) and reach their peak values around 1500 hrs IST. The decrease from afternoon to night is gradual as compared to winter season. The difference in temperatures of two fortnights of March is about 3 to 4 Deg. C at each hour of the day, in April the difference is around 2 to 3 Deg. C.. The difference at each hour is about 1 Deg. C for both fortnights of May indicating the slower increase in temperatures through the month of May. The days in April have 5-7 hours whereas the days in May are 8-9 hours of temperatures in excess of 35 Deg. C.

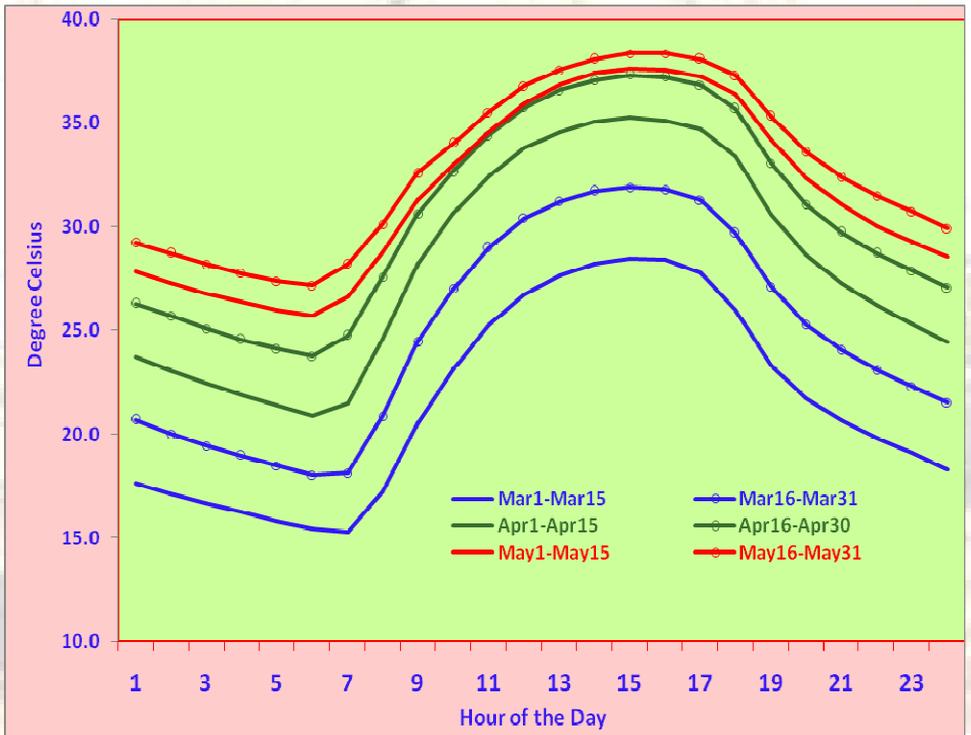
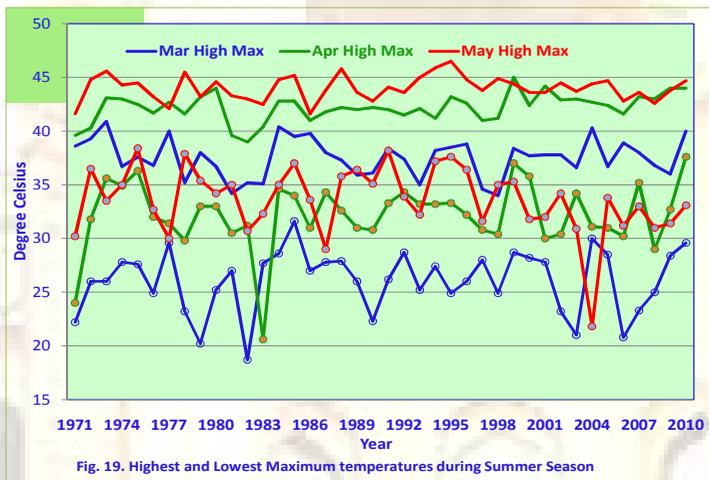


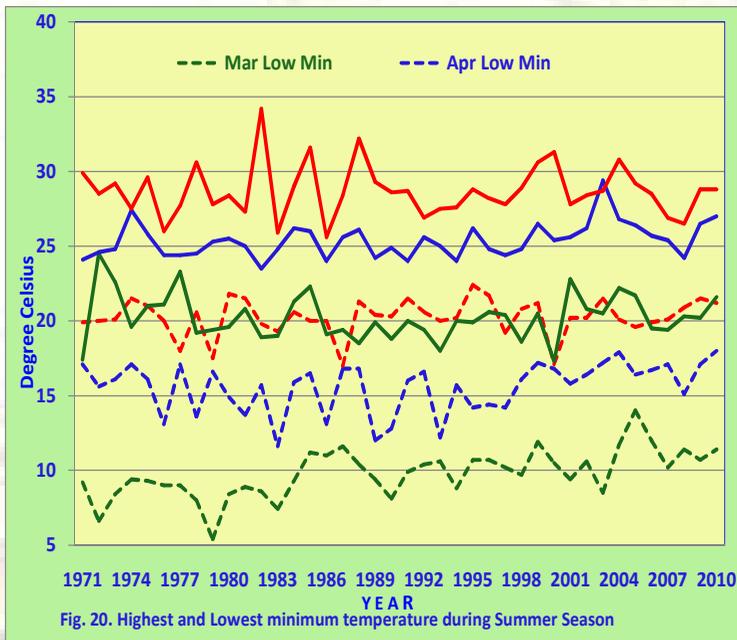
Figure 18. Diurnal Variation of Temperature during Summer Season

Extreme Temperatures

The highest and lowest maximum temperatures recorded during the season (1971 -2010) given in the Fig. 19 show that the average highest maximum temperature during the above period is around 36-38 Deg. C during March, 41-43 Deg. C during April and 43-45 Deg. C during May. The highest maximum temperatures reached during the period have been 40.9 deg. C in March (31 March, 1973), 45.0 deg. C in April (30 April, 1999) and 46.5 deg. C in May (31 May, 1995). However the maximum temperature could remain significantly lower when persistent cloudiness and rainfall/thunderstorm occur in the region in association with western disturbance. The dust storms/thunderstorms in the season are known to provide occasional relief from oppressive heat. The maximum temperatures recorded during the period have been as low as 18.7 deg. C in March (March 1982), 20.6 deg. C in April (April, 1983) and 21.8 deg. C in May (May, 2004) indicating that the day-time temperatures on individual days could be quite cold and pleasant.



The lowest and highest minimum temperatures (1971-2010) for different months given in Fig.20 show that the lowest minimum temperatures reach to about 8-10 Deg C. in March, 14-16 Deg C in April and 19-21 Deg .C in May during most of the years. However, The temperatures have fallen to as low as 5.4 Deg.C in (30 March, 1979), 11.6 Deg. C in (24 April 1983) and 17.0 Deg. C in (3 May 1987) during the period. The highest minimum temperatures on individual days could remain very high-in excess 20 deg. C in March, 25 deg. C in April and 30 deg. C in May leading to very warm night conditions (Figure 20). The mean maximum/ minimum temperatures and extreme temperatures ever recorded during the season arte given in Table 1.



The probability of maximum temperatures exceeding 35 and 40 Deg. C is given in Fig. 21 shows that the no such probability exists in the beginning of the season. It is only 20 March. The probability that the maximum temperature will exceed 35 Deg C is 30 % in the beginning of March and it touches 90% by the end of March. The probability is 95 to 100 % for temperatures to exceed 35 Deg C in April and May. The probability of temperatures to exceed 40 Deg C is nil upto 10th March but thereafter it increases from 30 % in the beginning of April to more than 80 % by April end. The probability of temperatures to exceed 40 Deg C is 75 to 90 % in May. The maximum temperatures on certain days remain 5 Deg.C or more than normal. Such condition is described as heat wave (Annexure 1). The daily normal temperatures for May are around 42 Deg C, therefore the heat wave condition is declared only when temperature exceeds 45 Deg C. The highest incidence of Heat wave is in May (1.9 days) and lowest in March (0.8 days). The highest number of days with heat wave has been 10 days in May, 2010.

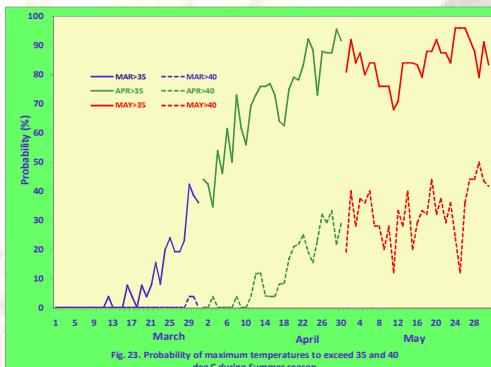


Fig. 23. Probability of maximum temperatures to exceed 35 and 40 deg C during Summer season.

Fig. 21. Probability of maximum temperatures to exceed 35 and 40 deg C during Summer Season

Humidity

The daily mean maximum and minimum RH (Fig. 22) show that the maximum RH gradually falls through the month of March from about 85% in the beginning to about 75% towards end of the month. The fall is rapid in the middle of the season and maintains 65% throughout March and starts rising gradually in April to reach 75% by the end of May. The minimum RH maintains around 20 to 25% throughout the summer season, increasing to more than 25% from first week of May maintains throughout the month.

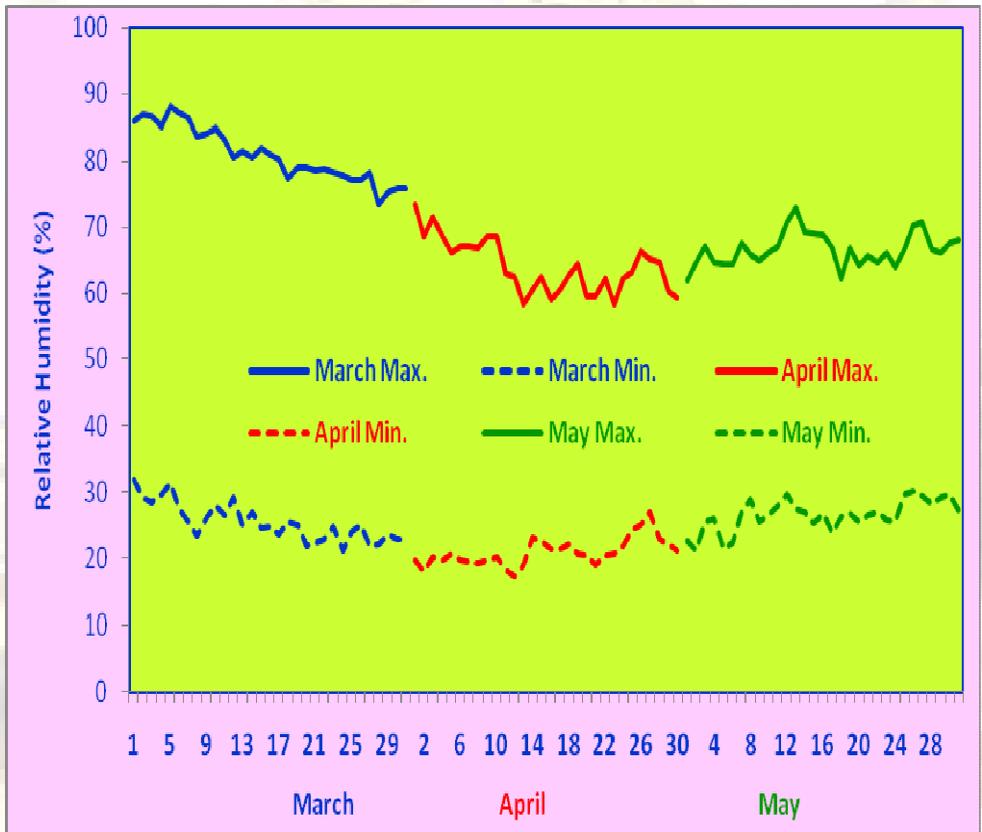


Figure 22. Normal Maximum and Minimum Relative Humidity during Summer Season

Diurnal Variation of Relative Humidity

The air is quite dry in the season, particularly during the day hours. The minimum RH in the afternoon may fall to as low as 15 to 20% on some of the days. The diurnal variation (Figure 23) of RH indicates that the highest RH is recorded around 0600-0700 hrs IST in the morning. There is a steep fall from 0800 hrs IST till 1300 hrs and the RH reaches its minima around 1600 hrs IST in the afternoon. The RH starts increasing from 1800 hours in the evening. The drop from morning to afternoon is about 52 % in March, 35-45% in April 35 % in May.

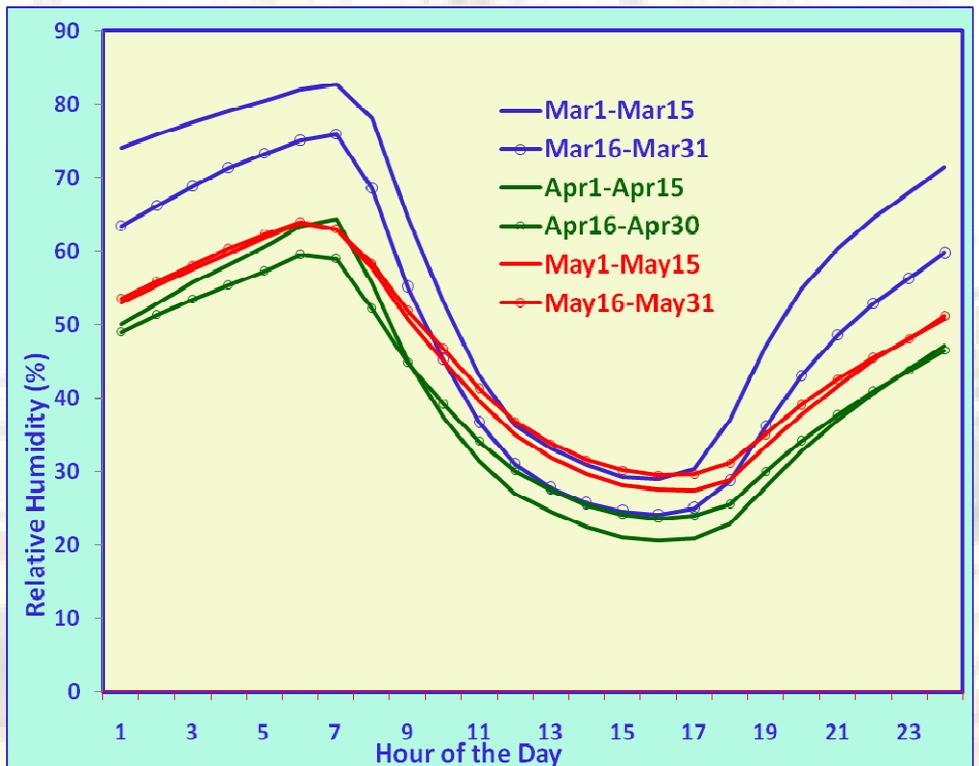


Figure 23. Diurnal Variation of Relative Humidity in Summer Season

Rainfall

Like winters, summer is also dry season for Lucknow. Most of the rainfall is caused by the eastward moving western disturbances and is associated with thunderstorms on most of the days. On some occasions thunderstorms are also induced by thermal convection when incursion of moisture takes place from Arabian Sea in association with southwesterly winds. April is the driest month and May is the wettest with total monthly rainfall 5.0 mm and 18.4 mm, respectively. The daily rainfall, although less, indicates a gradual rise as the season advances (Fig. 24).

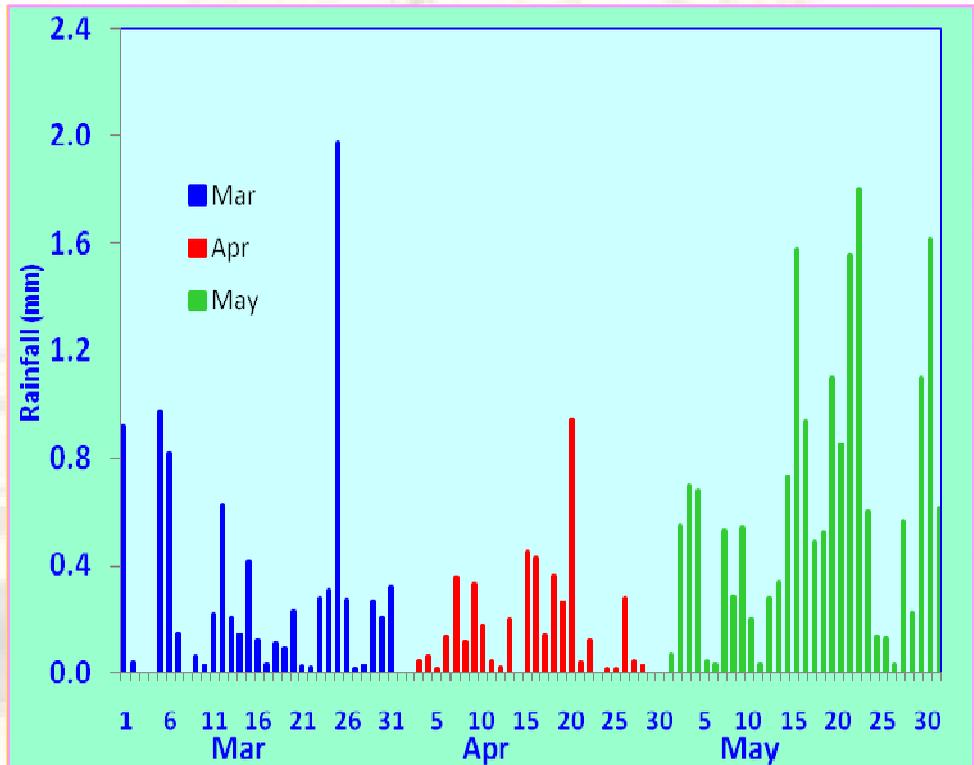


Figure 24. Daily Normal Rainfall for Summer Season

Average number of days with rain is 1.0 for March, 0.6 for April and 1.6 for May (Table.4). Figure 25 shows, that the average probability of rainfall for each day is around 7% in March, April and around 11% in May.

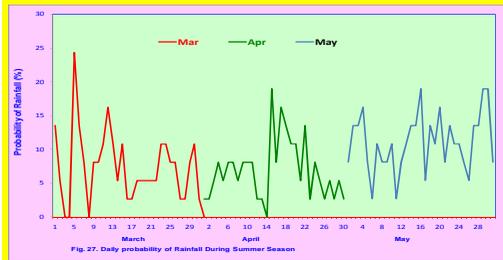


Figure 25. Daily Probability of Rainfall During Summer Season

Like winter season, summers also do not normally experience heavy rains. The heaviest rainfall during different months in the season (Fig. 26) shows that most frequently occurring heaviest 24 hours rain in the season is 2-3 cm. The record for heaviest rainfall for study period are 42.5 mm in March (25 March, 1982), 16.6 mm in April (4 April, 1982) and 54.4 mm in May (22 May, 2000).

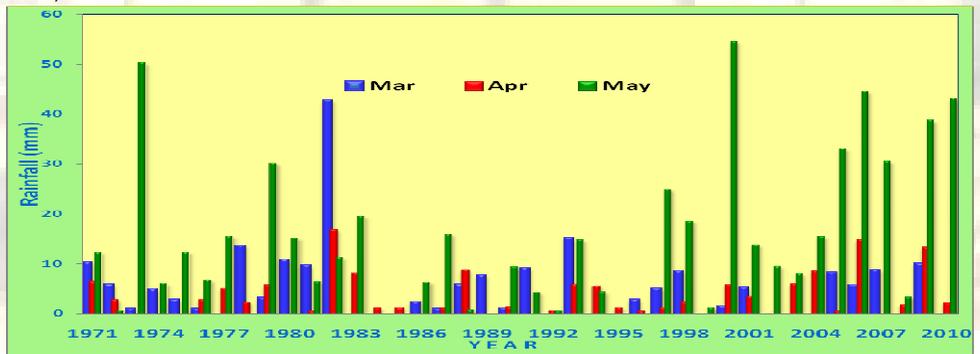
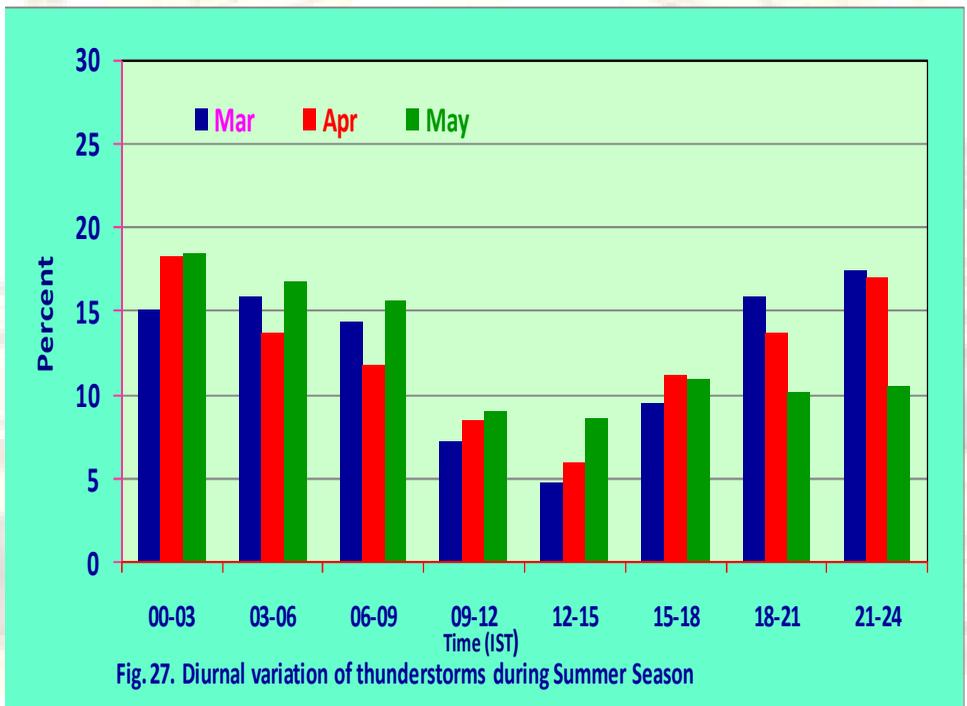


Figure 26. Heaviest 24-hours rainfall for Summer Season

Thunderstorm and other Weather Phenomena

The summer season in Northwest India is generally characterized with severe weather phenomena like dust storms, thunderstorms, hails and squalls. These phenomena are associated with tall cumulonimbus (Cb) clouds which form in the field of upper air divergence ahead of eastwards moving troughs in middle and upper tropospheric westerlies. Thermal convection also causes thunderstorms in afternoon/evenings when sufficient moisture is available in the atmosphere. The severe downdraft from the Cb clouds result in convective dust storm/squall. The average number of thunderstorms during the season are 2.0 in March, 2.0 in April and 4.2 in May. The diurnal variation of thunderstorms (Figure. 27) shows that late night/early morning (0000-0600 hrs) are the most preferred time for occurrence of thunderstorms. The average number of weather phenomena during the season, are given in Table.4.



Impact of Thunderstorms/Dust storms on temperatures

The dust storms/thunderstorms, though known for causing loss of life and property and other inconveniences, do provide relief from the oppressive heat of the summer season. On an average, there are two or three occasions when the maximum/minimum temperatures fall by 4-5^o C in 24 hours due to these thunderstorm activities. The maximum temperature on 10 March 2006 was 13.5 °C lower than that of previous night also the night of 22 March 1983 was 7.6 °C cooler than that of previous night. The highest fall in maximum and minimum temperatures during different months are given in table 7.

The total number of squall for the study period have been 4 during March, 17 during April and 32 during May. The highest number of squall during any month in the season has been 4 in May 1987 and May 2008. North-West to North is the most prevalent direction of squall as more than 50% squalls approached from this direction (figure 28). The strongest squall during the above period has been of on 167 kmph on 19 May, 2009.

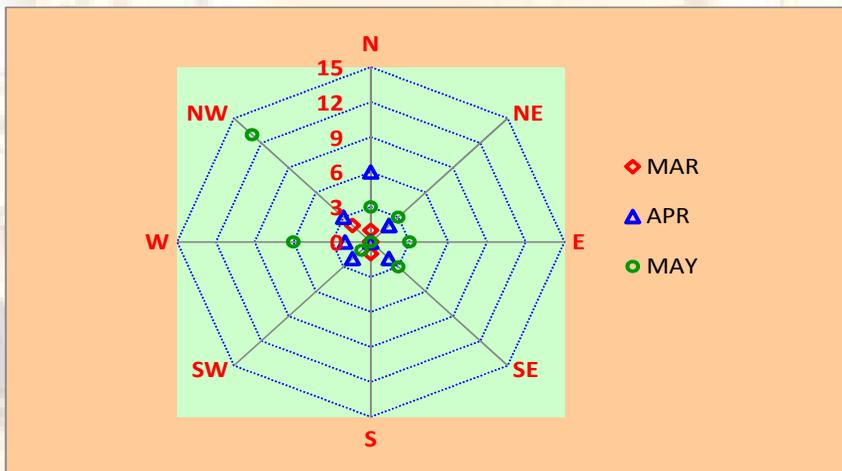


Fig. 28. Frequency of approach of squalls from different direction during Summer Season

Wind

Increased insolation and occasional steep pressure gradients over northwest India makes summer a relatively windy season for Lucknow. In fact, it is the windiest season for Lucknow as both the average winds and the strength of squall is highest. The average wind speed is 4 to 7 kmph from 2000 hrs in the night to 0700 hrs IST in the morning. As the sun rises, wind speed starts rising from 0700 IST and reach the peak around 1500 IST in the afternoon in the month of March and April. The maximum in the month is around 1400 IST in the afternoon. The wind speed drops drastically after 1700 hrs IST in the evening. The increase in wind speed from morning to afternoon is highest during April than other two months. The most prominent wind direction in the morning remains West to northwesterly in March and April and Easterly in May. In the evening northwesterly is the most prominent wind in the season however frequency of Easterly wind increases in the month of May (Fig.29) The winds tend to rotate anticlockwise as the season progresses.

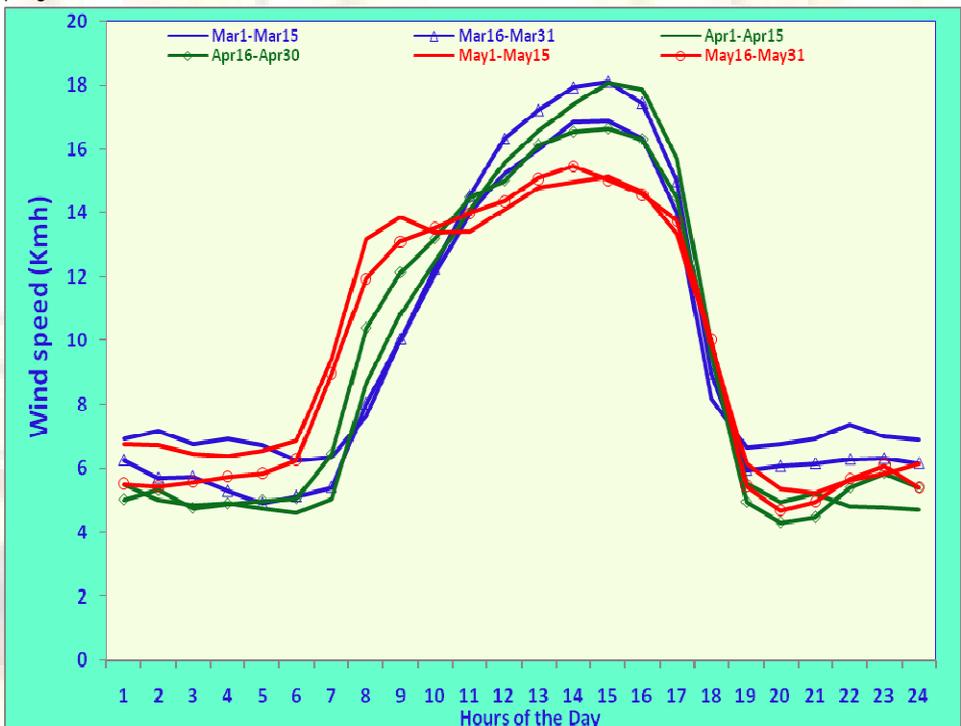
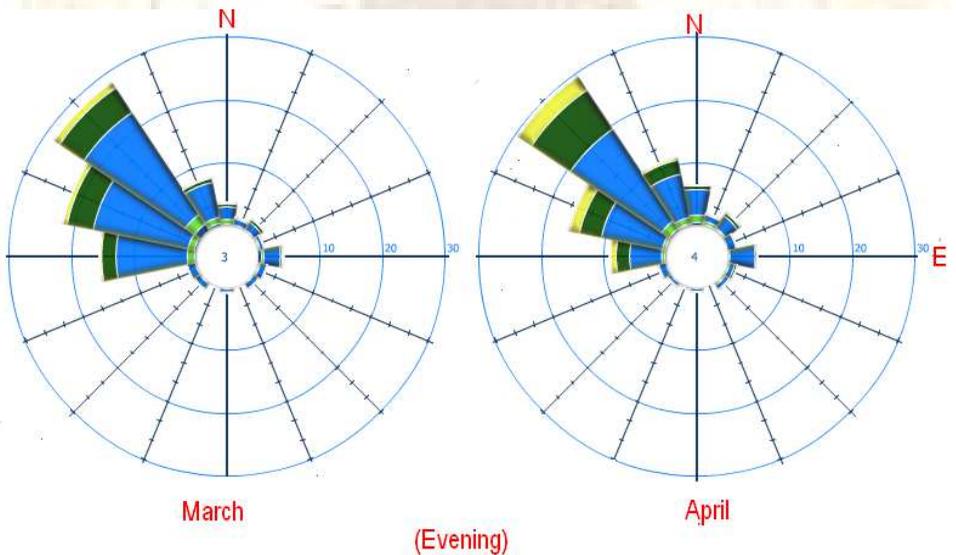
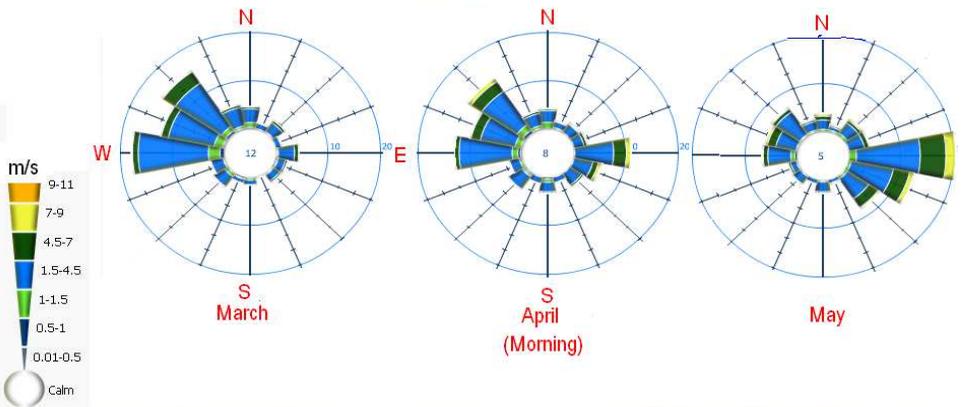


Fig. 29. Diurnal variation of wind speed during Summer Season

Wind roses of summer season



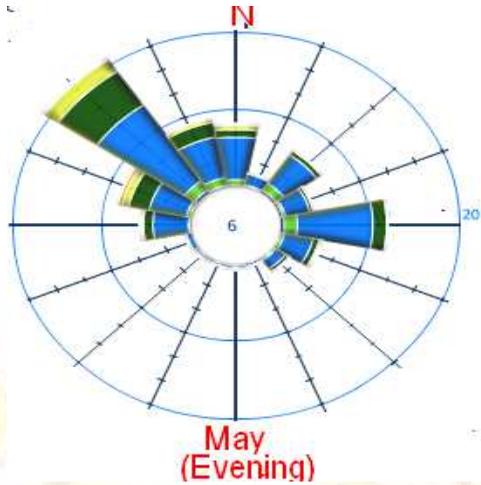


Fig.30. Wind Roses of Summer Season

Though the average wind speed is 10 kmph during the season, the wind speed exceeds 10 kmph in more than 70 % days in March and April. The lowest probability (>60%) being for the month of May (Fig.31).

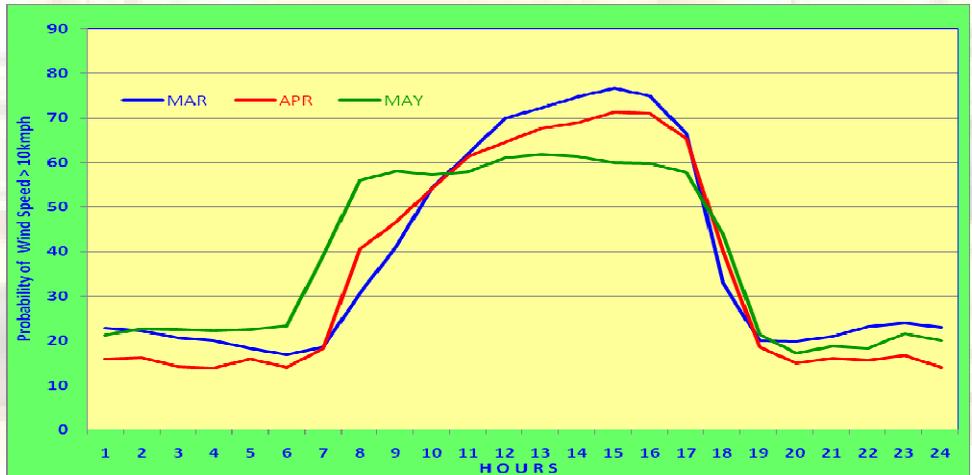


Fig. 31. Probability of wind speed to exceed 10 kmph during Summer Season

Monsoon Season

This is the main rainy season for most parts of India including Lucknow. Frequent rainfall/thunderstorms, occasional heavy rains are characteristic features of this season.

Onset and withdrawal of Monsoon.

The southwest monsoon sets in over Kerala around 1st June. It takes around 15 to 20 Days to travel to Uttar Pradesh. The average date of onset of southwest monsoon over Lucknow is 21st June. The dates of onset of southwest monsoon over Lucknow from 1981 to 2010 are given in Fig. 32 below. The southwest monsoon enters Lucknow in the Second fortnight of June and withdraws after 30th September. It affects Lucknow for more than three months. In the period considered the earliest date of onset has been 8th June in 2000. The latest onset date was 7th July in 1987. The earliest withdrawal date was 16th September in 1982. The latest withdrawal date was 13th October in 1990.

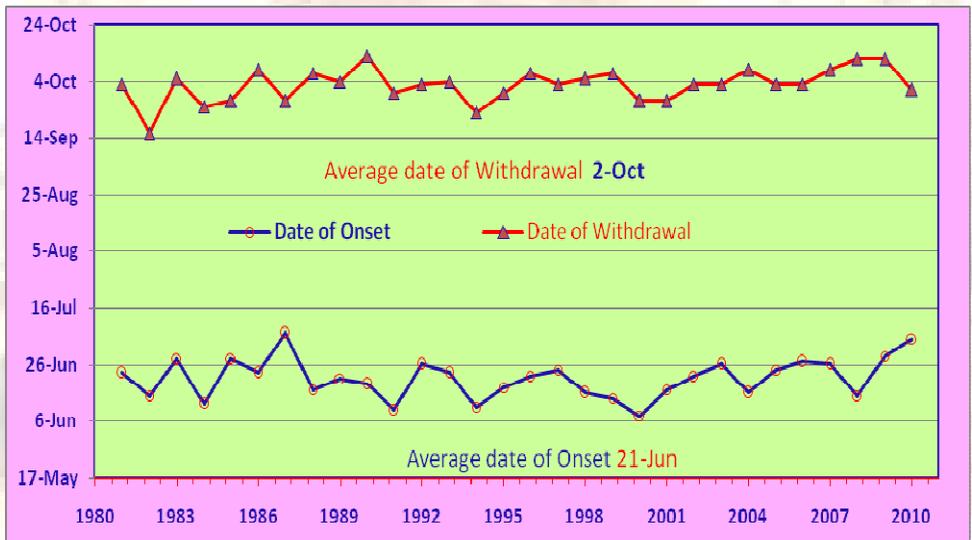
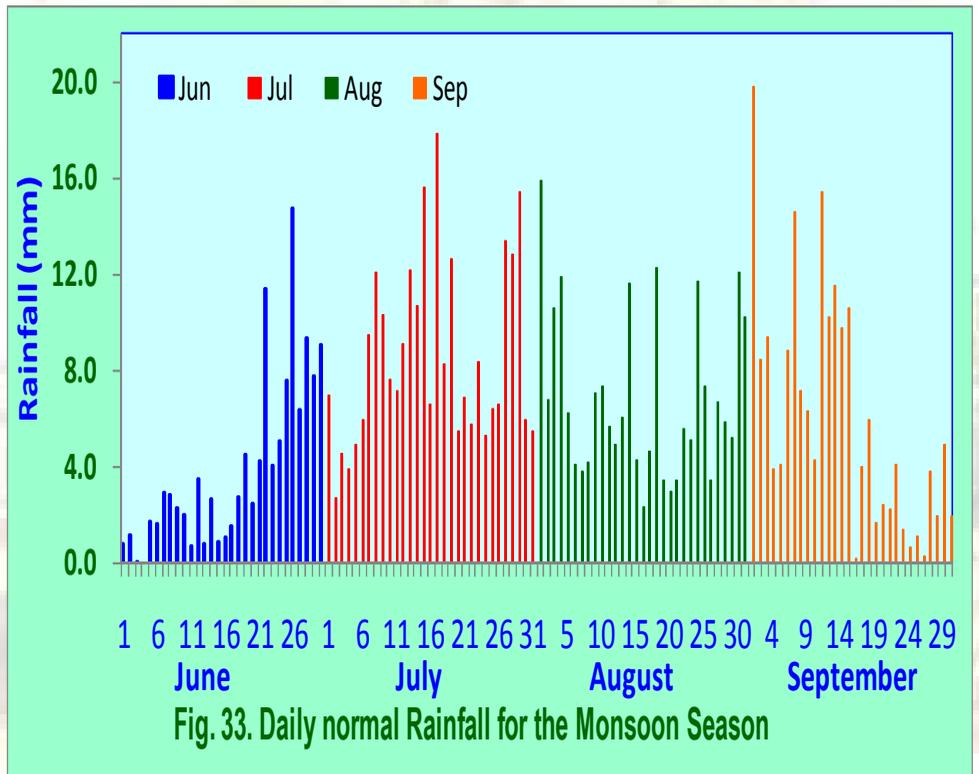


Figure 32 Dates of onset and withdrawal of SW-Monsoon Season

Rainfall

Monsoon is the rainy season for Lucknow. Though the monsoon sets in the second fortnight of June only, the pre monsoon showers start from the first week of June. Last week of June to 2nd week of September is the rainiest period with daily normal rainfall around 6 to 8 mm. There is a gradual decrease from 14th September and afterwards a drastic fall (Fig.33.). July and August are the rainiest months and they together contribute about 60 % to the total seasonal rainfall of 775 mm.



The daily probability of rainfall increases from about 10 to 20 % in the beginning of June to 50-60 % by the end of the month (Fig.34.). It further increases to more than 60-70% in the last week of July and further maintain in between 50-60% till first fortnight of September. It decreases sharply after that and falls to 20% by the end of the season. Average rainy days are 7.2 and 11.7 for June and September and 16.8 and 16.2 each for July and August respectively.

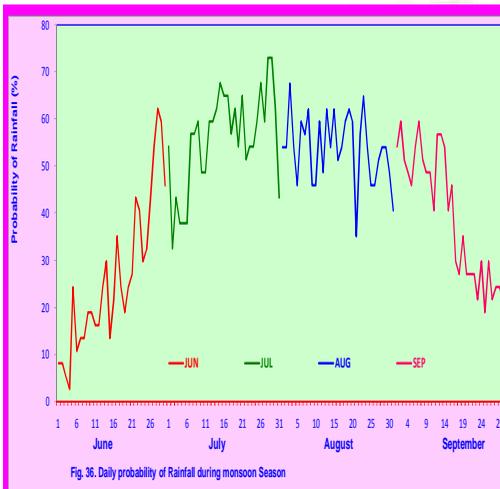


Fig. 34. Daily Probability of Rainfall during monsoon Season

Heavy Rainfall

Lucknow receives heavy rainfall on some occasion during the season. The heavy rains are caused by monsoon disturbances like cyclonic circulations, low pressure areas and monsoon depressions, which develop in Bay of Bengal and move in West-northwestwards along the monsoon trough. The heaviest 24 hours rainfall during different months in the season (Figure 35) show that the most frequently occurring heaviest 24 hours rain in the season is 5 to 10 cm. However, rainfall of 10-12 cm also occurs on one or two occasions during the season. The average number of days with heavy rainfall ($\geq 65\text{mm}$) is 1 for July, August and September and less than one for June. The all time record heavy rainfall for June, July, August and September have been 182.4 mm (26th June, 1971), 311.6 mm (15th July, 1947), 250 mm (30th August, 2000), 250.1 mm (13th September, 1915).

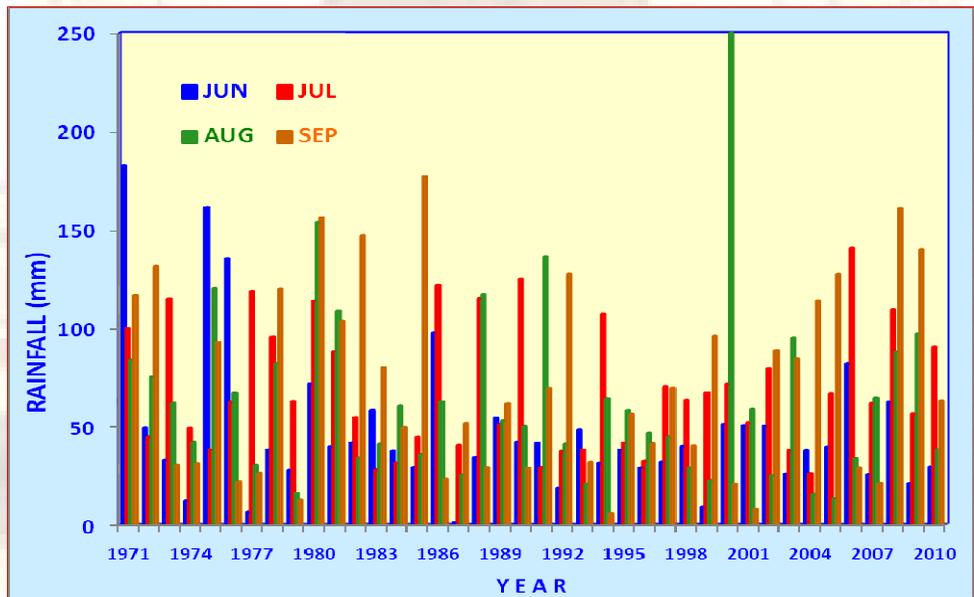


Fig. 35. Heaviest 24-hours Rainfall for the Monsoon Season

Thunderstorm and other weather Phenomena

The severe weather phenomena of summer season- thunderstorms squalls continue occur in Monsoon season also like thunderstorms occur mostly during monsoons in Lucknow. This is season when highest number of thunder storm are recorded in Lucknow. Frequency of dust storm fall drastically from July onwards due to monsoon rain. The frequency of all other weather phenomena (hail, squall) is quite low (Table 2). The average numbers of Thunderstorms during the season are 6.4 in June, 10.7 in July, 9.5 in August and 6.7 in September. The diurnal variation of thunderstorms (figure 36) shows that afternoon/evening hours (1500-2100 hours) are the most preferred time for occurrence of thunderstorms. The average numbers of weather phenomena during the season are given in Table 4.

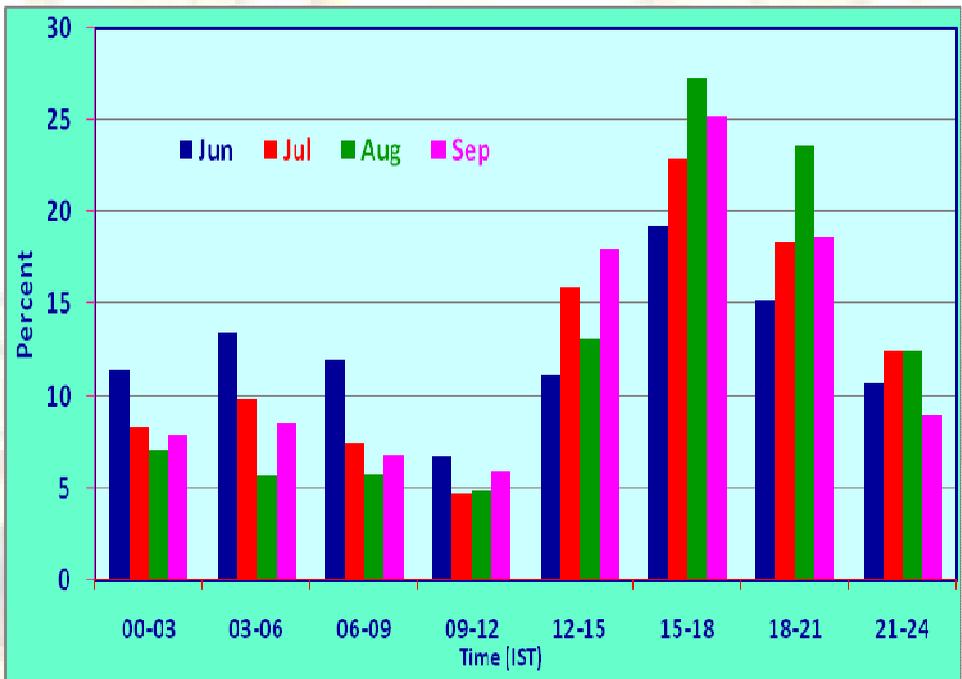


Fig.36 Diurnal variation of thunderstorms during Monsoon Season

The thunderstorm, on many occasion, are associated with dust storms and squall. As the atmosphere becomes more stable with progress of the season, their occurrence goes down. The total numbers of squall for the study period have 22 in June, 10, 8 and 5 in the month of July, August and September respectively. Their frequency varies in different years with no squall phenomenon in many years and highest number of 5 squall in the month of June 1982. North-west to north-east is the most prevalent direction of squall during the season (Figure 37). The strongest squall during the above period has been of 135 kmph on 2 July 2009.

The dust storm/thunderstorms continue to provide relief from the oppressive heat during the hot month of June as in the summer season. For the month of June, the highest fall in 24 hours has been 10.8 °C in maximum temperature on 13 June, 2007 and 7.6 °C in minimum temperature on 23 June, 2005 and 06 June, 2009 (Table 7).

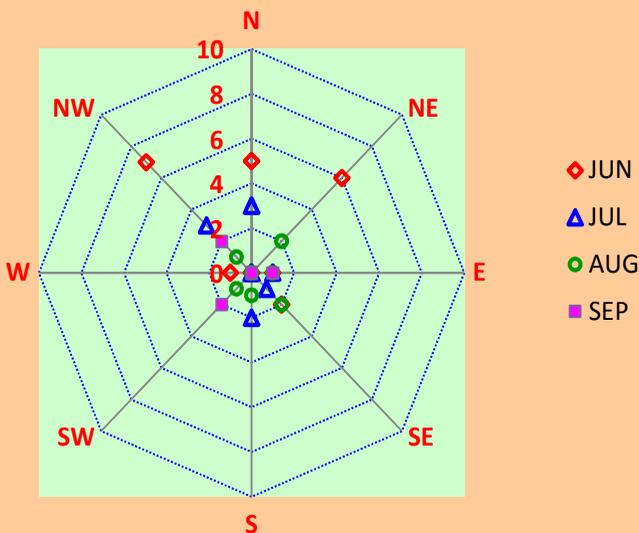


Figure 37 Frequency of approach of squalls from different direction during Monsoon Season

Temperatures

The season begins on a warm note with daily normal maximum temperatures around 41 Deg. C in the beginning of June (Fig. 38) .They start falling after the first week of June and the drop is very steep as pre-monsoon showers cool the atmosphere. They continue to drop further reaching around 33 Deg C in the middle of July. Afterwards the drop is arrested and the normal maximum temperatures hovers 33-34 Deg. C till end of the season. A slight warming is noticed occasionally in the last week of September. The minimum temperatures also fall during the monsoon period very slowly and steadily from 27 to 24 Deg. C by the end of the season.

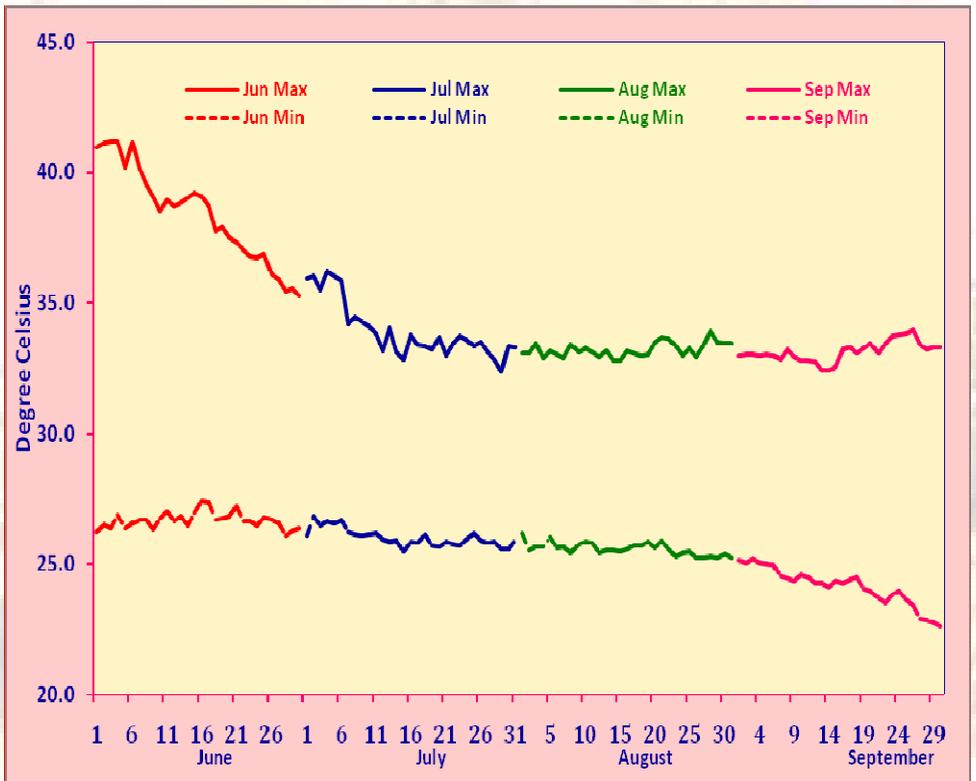


Fig. 38. Normal Maximum and Minimum temperatures for the Monsoon Season

Diurnal Variation of Temperature

The diurnal variation in temperatures given in Figure 39 shows that the lowest temperatures in a day are realized around 0600 IST during June and first around 0700 IST in July August and September. The highest temperatures are recorded around 1500 IST all through the season. Monsoon is the season of least Diurnal variation in temperatures. The figure shows a decrease in range of temperature as the monsoon approaches. It decreases from 9 Deg C during the first half of June to 6 deg C in the second half and further to 5 Deg C in the first half of July. Thereafter it remains around 4 Deg C during second fortnight of July till the first fortnight of September. The diurnal range increases to 6 Deg C in the second half of September. The peak hour temperatures during the two months period of mid-July to mid-September are about 6 Degree cooler than those of the first fortnight of June.

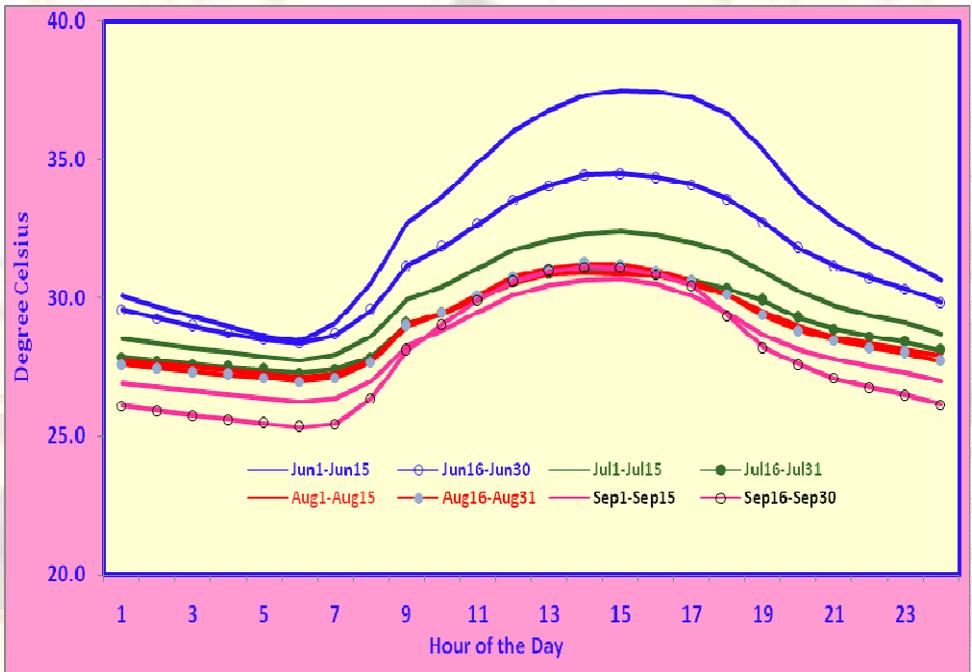
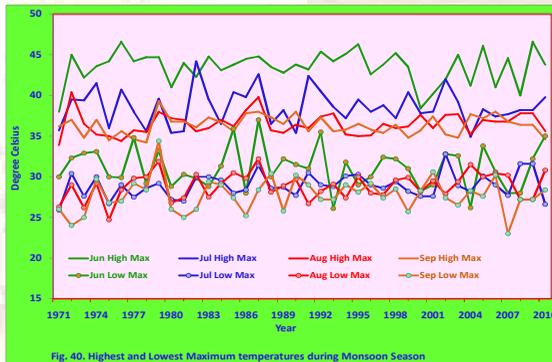


Fig. 39. Diurnal Variation of temperatures during Monsoon Season

Extreme Temperatures

The highest maximum and lowest maximum temperatures recorded in the month of June- September during 1971-2010 given in Fig 40 show that highest maximum temperatures during June reach 43 to 45 Deg C during most of the years. However, the maximum temperature reached during 1971 was only 38 Deg. C (14 June, 1971). Highest maximum temperatures attained during July are highly variable; they are mostly ranging between 37 Deg C to 41 Deg C. They have reached 44.2 Deg. Cels. during the year of 1982 (6 July) These temperatures, during most of the years have ranged between 35 and 37 Deg C during August and September. However the weather on individual days could become very pleasant in association with widespread rains in the region. The lowest maximum temperatures recorded in different months have been 26.1 Deg. C (28 June, 1993), 25.9 Deg. C (12 July, 1971), 24.7 Deg. C (27 August, 1975) 23 Deg. C (25 September, 2007).



The lowest and highest minimum temperatures for the season given in the Fig.41 show that the most frequently occurring lowest minimum temperature is between 20 and 25 Deg. C. during the season. However, minimum temperatures occasionally fall below 20 Deg. C especially first three months of the season. The lowest minimum temperature recorded during the study period was 19.7 Deg. C (12 June, 1979), 21.5 Deg. C (28 July, 2007), 21.4 Deg. C (16 August, 1997) and 17.8 Deg. C (30 September, 1984). Persistent widespread rains and the consequent cooling of the atmosphere results in these abnormally low minimum temperatures. However, the minimum temperatures could remain significantly high on certain days. This normally happens due to either cloudy nights or dust suspended in the atmosphere allowing nocturnal cooling. The highest minimum temperatures have exceeded 30 Deg. C many years during June, and of course in few years in the month of July and August but never in the month of September during last 40 years. The extreme temperatures for each month are given in Table 1. Deg C from July to September.



Fig. 41. Lowest and Highest Minimum Temperatures during Monsoon season

The probability of maximum temperatures to exceed 35 and 40 °C during Monsoon season given in Figure 42 show that the probability of maximum temperatures to exceed 35 °C is above 90% in the first week of June. It then starts falling due to beginning of pre-monsoon showers. It falls to around 50% by the end of June. There is a steep fall after onset of monsoon and it falls to 15-20% by the end of July. It remains fluctuates between 15-25% by the end of the season. Lowest probability to exceed 35 °C is in the third week of September. The probability of maximum temperature to exceeds 40 °C falls from around 60% in the beginning of the season to less than 10% by the end of June. It is less than 10% by the middle of July. No such probability exists during last two and half months except last week of July and first week of August when probability to exceed 40 °C is less than 5% is seen due to break of monsoon.

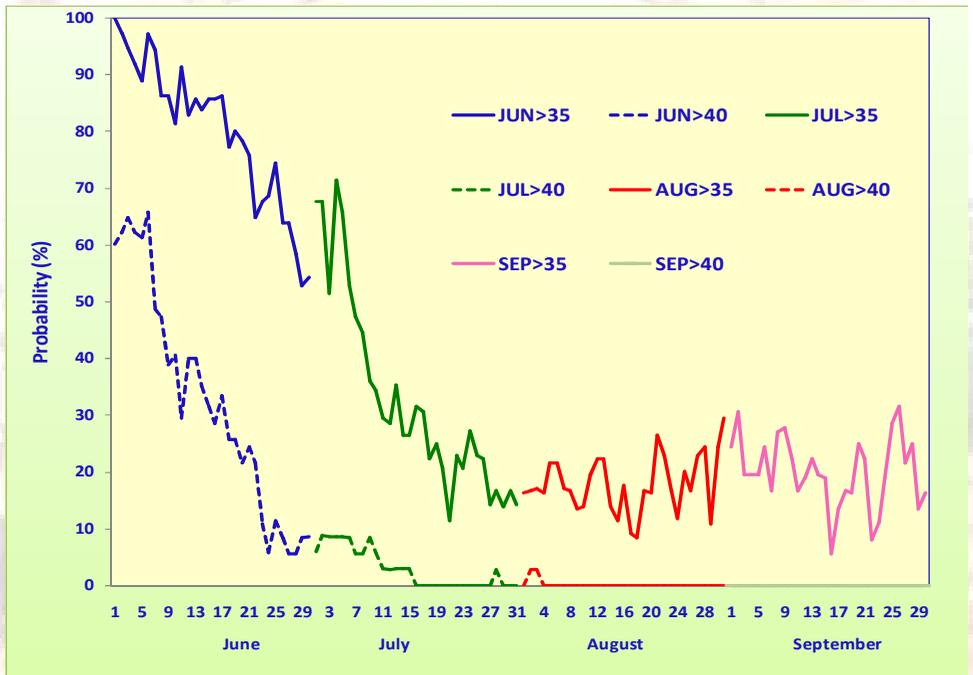


Fig. 42. Probability of Maximum Temperature to exceed 35 and 40 deg. C in Monsoon Season

Humidity

The daily mean maximum and minimum Relative Humidity (RH) given in Fig. 43. show that the maximum RH is quite around 65% in the beginning of the season . It increases to 90% by the end of June and maintains till September end. The daily minimum RH also follow the similar trend with low values around 25% in the beginning of the season and increases up to 60% in the end of the June and then it maintain between 65 to 70% till end of the season.

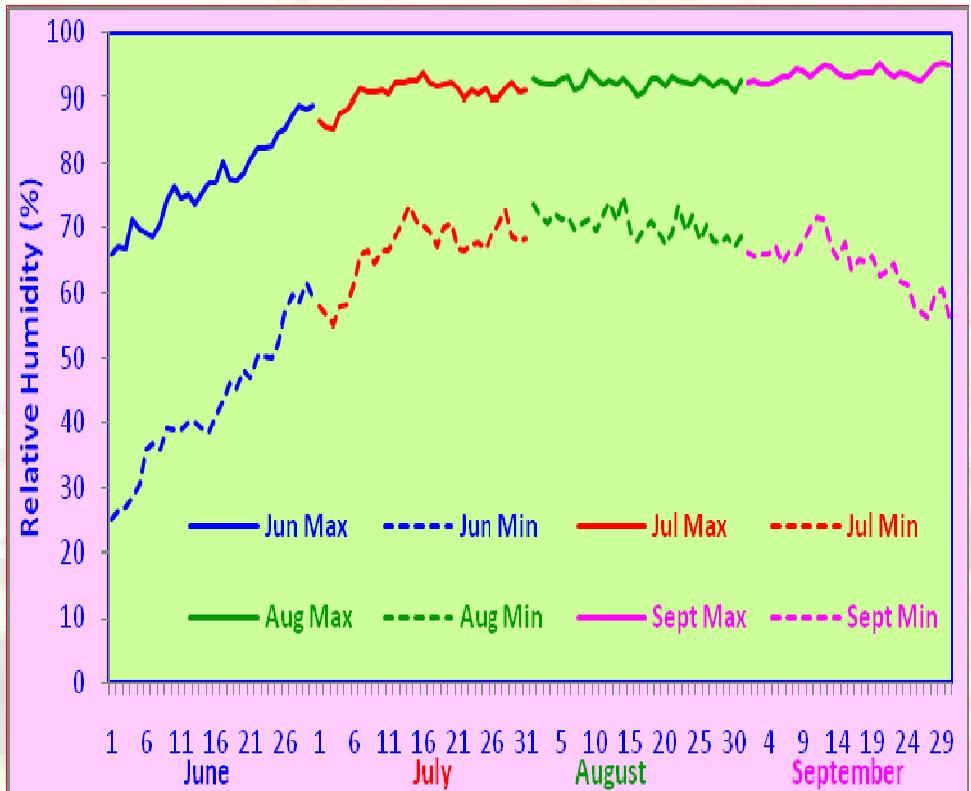


Fig. 43. Normal Maximum and Minimum Relative Humidity for Monsoon Season

Diurnal Variation of Relative Humidity

The diurnal variation of RH (Figure 44) shows that the highest RH is recorded at 0700 hrs IST in the season. It declines from 0800 to 1500 hrs IST with a gradual fall afterwards till 1600 hrs IST. The lowest RH at all hours is recorded in the first fortnight of June; and the highest value at all hours fluctuate in different fortnight of the months. The diurnal range is highest in the first fortnight of June.

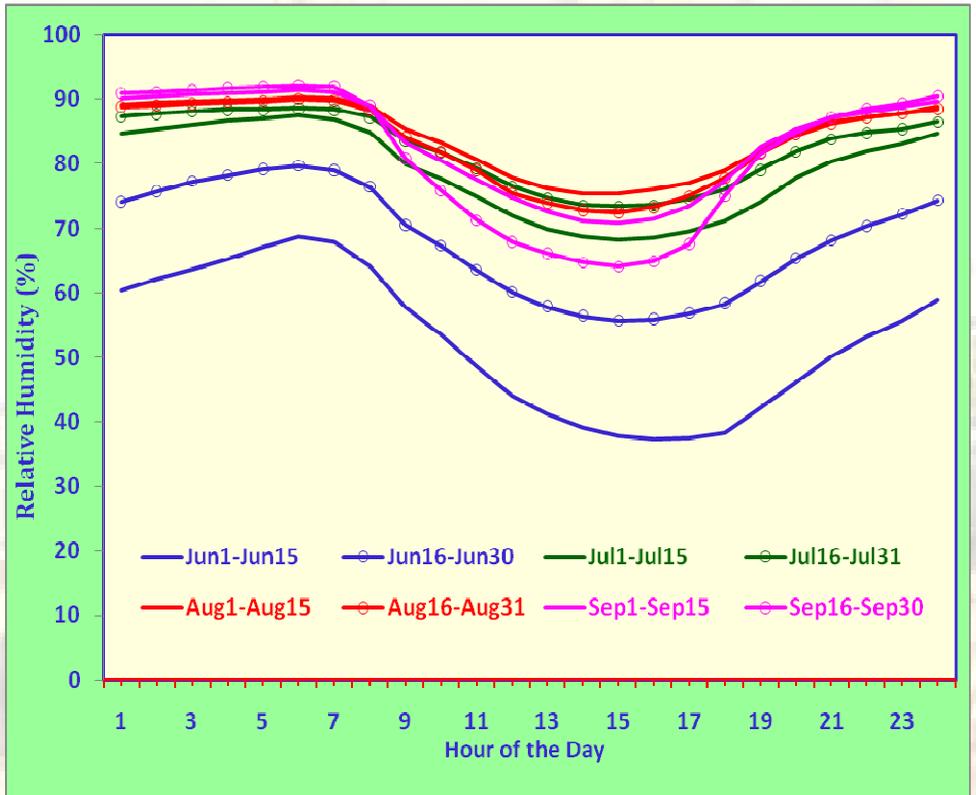


Fig. 44. Diurnal Variation of Relative Humidity in Monsoon Season

Wind

The average wind speed decreases in monsoon season compared to the summer season the decrease continues as the season progresses. is higher in the month of June and July as compared to August and September. The average winds are the strongest in June and fall progressively till end of August. The again increase in the first fortnight of September before falling to their lowest values in the second fortnight of September.

The peak average wind speed are around 14 kmph in first fortnight of June and it decreases till August as the season progresses. Once again it rises up to 15 kmph in the first fortnight of September and further decreases up to 11 kmph in the second fortnight of September. The diurnal variation is around 8-9 kmph through out the season (Fig.45).

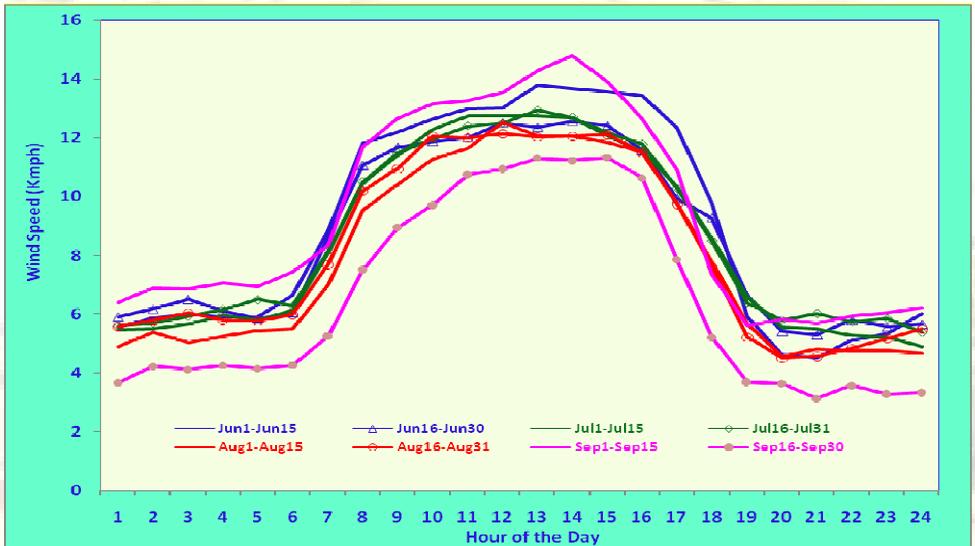


Fig. 45. Diurnal Variation of Wind Speed during Monsoon Season

The wind roses in Figures 46 shows that the Easterly component remain prominent throughout the season. The frequency of Westerlies, however, increases in the month of September increases due to retreating of the monsoon. Occasional

westerly component of wind is also found in other months of the season due to break in monsoon.

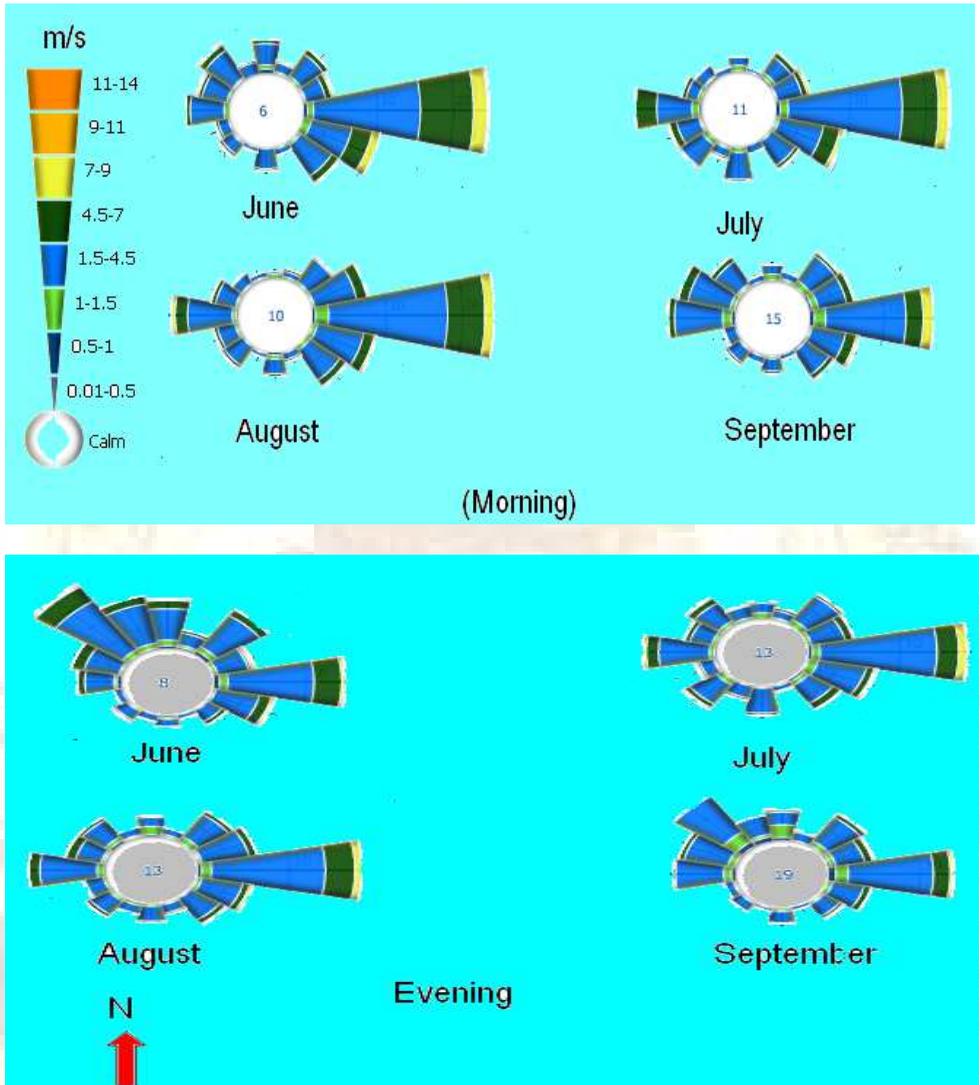


Figure 46 Wind Roses of Monsoon Season

Though the average wind speed is 14 kmph during the season with average peak wind speed 17-19 kmph during the season , the wind speed exceeds 10 kmph in 50-55 % days during the season from 0900 hrs IST to 1700 hrs IST. (Fig.47).

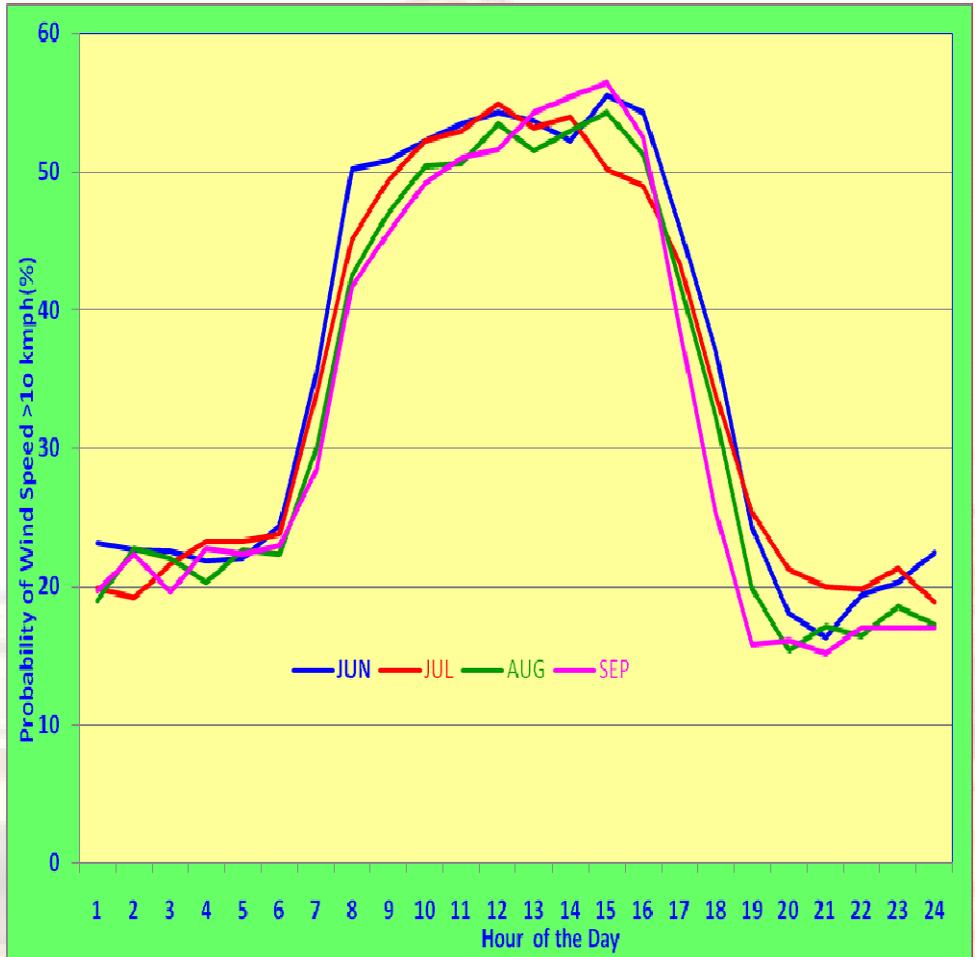


Figure 47. Probability of wind speed to exceed 10 kmph during Monsoon Season

Post Monsoon season

The post monsoon season (October- November) is a transit season between monsoon and winters. The season is characterized by generally dry and pleasant weather with a constant decrease in mean temperatures. With the retreat of southwest monsoon from the region, weather becomes fairly dry. Major Hindu festivals like, Navratri, Dusshera and Diwali fall in this season.

Temperatures

The season is marked by decreasing temperatures (Fig. 48) due to continued southward march of the sun. The mean maximum temperatures fall from 34 Deg C in the beginning of the month to 26 Deg C by the end of the season. The mean minimum temperatures fall from 22 Deg C in the beginning of the season to 10 Deg C by the end. The decrease in both maximum and minimum is relatively smooth through the season

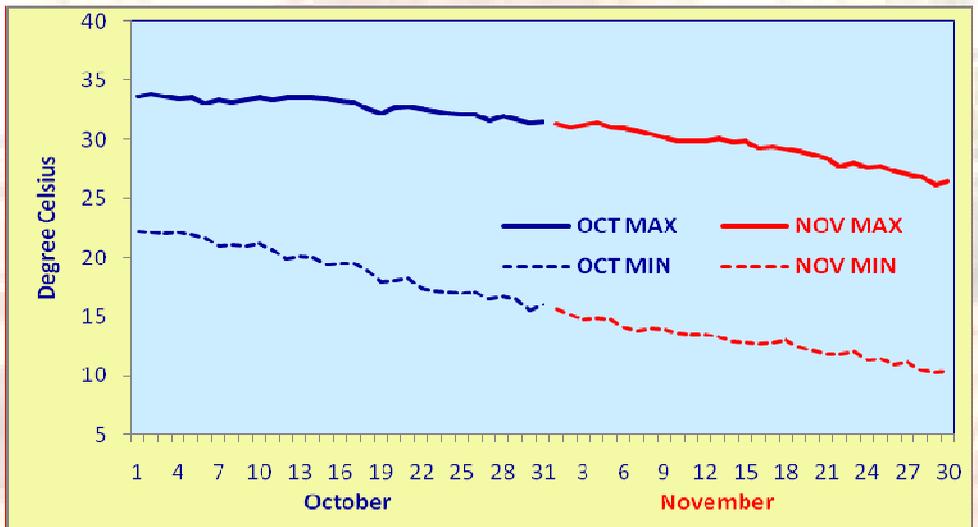


Figure 48. Normal Maximum and Minimum temperatures for Post Monsoon Season

Diurnal variation of temperature

The diurnal variation of temperatures in the season (Fig. 49) is similar to many other months in the year with lowest temperatures in the day occurring around 0700 hrs IST. A sharp increase is noticed from 0800 to 1300 hrs IST before they peak around 1500 hrs IST. The fall in temperatures from afternoon to evening becomes steeper as the season progress. The drop in temperature from 1700 hrs IST to midnight is about 6 Deg. C in first half of October and about 8 Deg C in the latter half of November.

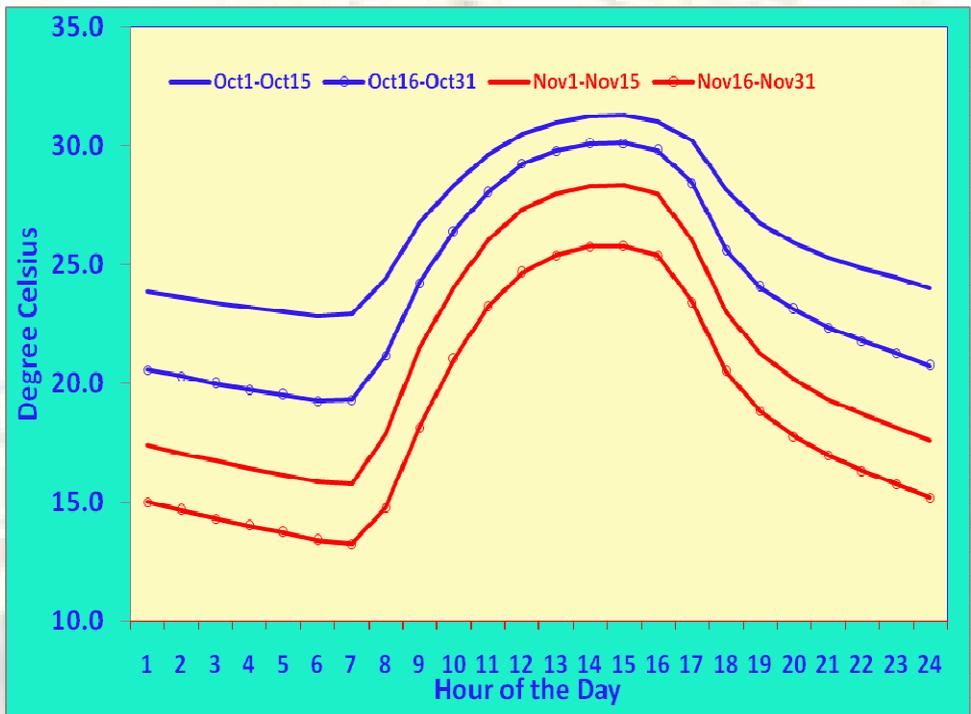


Figure 49. Diurnal Variation of Temperature during Post Monsoon Season

Extreme temperatures

The highest maximum and lowest maximum temperatures recorded in the month of October and November during 1971 -2010 given in Fig. 50 show that highest maximum temperatures during October are realized between 34 to 36 Deg C and those during November between 31 to 33 Deg C. However they have touched 38 °C in 1999 (15 October, 1999) due to deficient rains in the preceding monsoon season. The maximum temperature on 1 November 2001 reached 35.1 °C which was second highest record of the month and all time record was 38 °C on 8 November 1963. The maximum temperature could remain quite low on individual days (21.3 °C October 1972 and 18.7 °C November 1997).

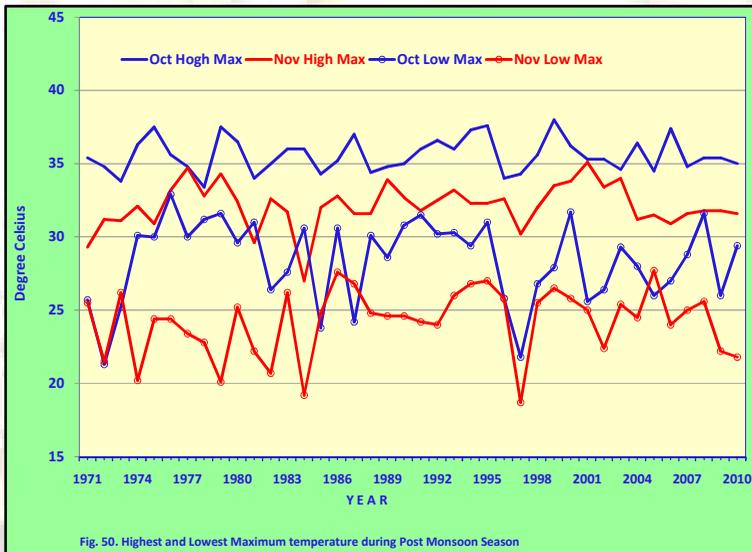


Fig. 50. Highest and Lowest Maximum temperature during Post Monsoon Season

The lowest and highest minimum temperatures for the two months given in Fig. 51. show that the most frequently occurring lowest minimum temperature is 14 to 16 Deg. C during October and 8 to 10 Deg. C during November. However, minimum temperatures have reached as low as 10 Deg C in 31 October, 1984 and 4.9 Deg. C in 25 November, 1975. The minimum temperatures could also remain significantly high on certain days.

The highest minimum temperatures during the period of study have been 29.5 Deg C in 8 October, 2001 and 21.6 Deg. C in 14 November, 2009. Like the winter season, the high minimum temperatures are caused by cloudy nights and warm air incursion ahead of an approaching western disturbance; and the significantly low minimum temperatures are caused by cold northerly winds from Himalayas after the passage of a western disturbance

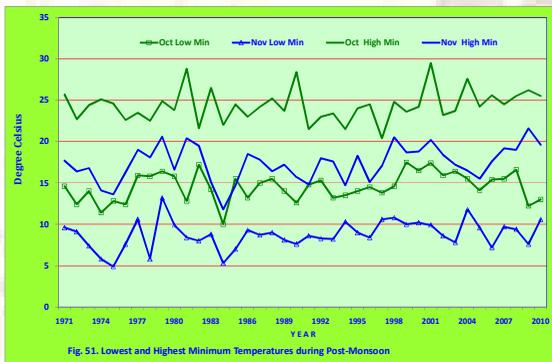


Fig. 51. Lowest and Highest Minimum Temperatures during Post-Monsoon

The probability of Maximum Temperature to exceed 30 Deg. C (Figure 52) remains very high (> 90%) during October. It falls to around 70% in the first week of November and falls very rapidly up to 40% by middle of month further to less than 10% in the last 10 days of the month. The probability of minimum temperature to fall below 10 Deg. C starts in the month of November but it is less than 5% in the first week of month and reaches up to 40% by the end of the season.

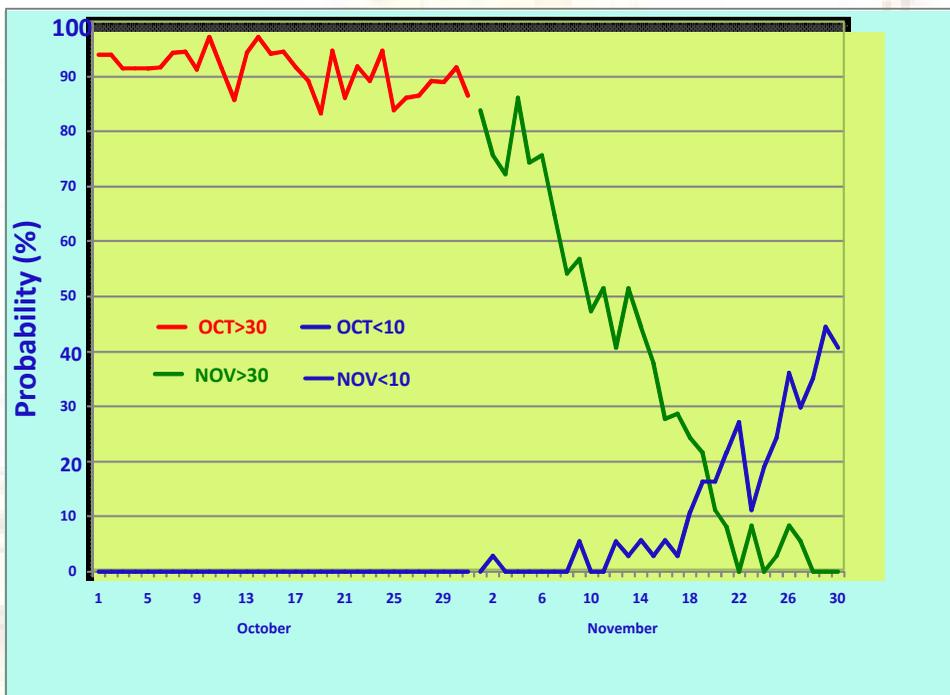


Fig. 52. Probability of Maximum Temperature to exceed 30 Deg. C and of the Minimum Temperature to fall below 10 Deg C during Post Monsoon Season

Relative Humidity

Though the weather becomes dry in the season, the maximum RH continues to remain high as the fall in temperatures compensate for the decrease in atmospheric water vapour content. Large changes in RH are not experienced with the progress of the season. The maximum RH is, in between 90 to 95% throughout the (Fig.53). The minimum RH is around 50 % in the first week of October it gradually decreases as the season progress and is around 35 % in the month of November.

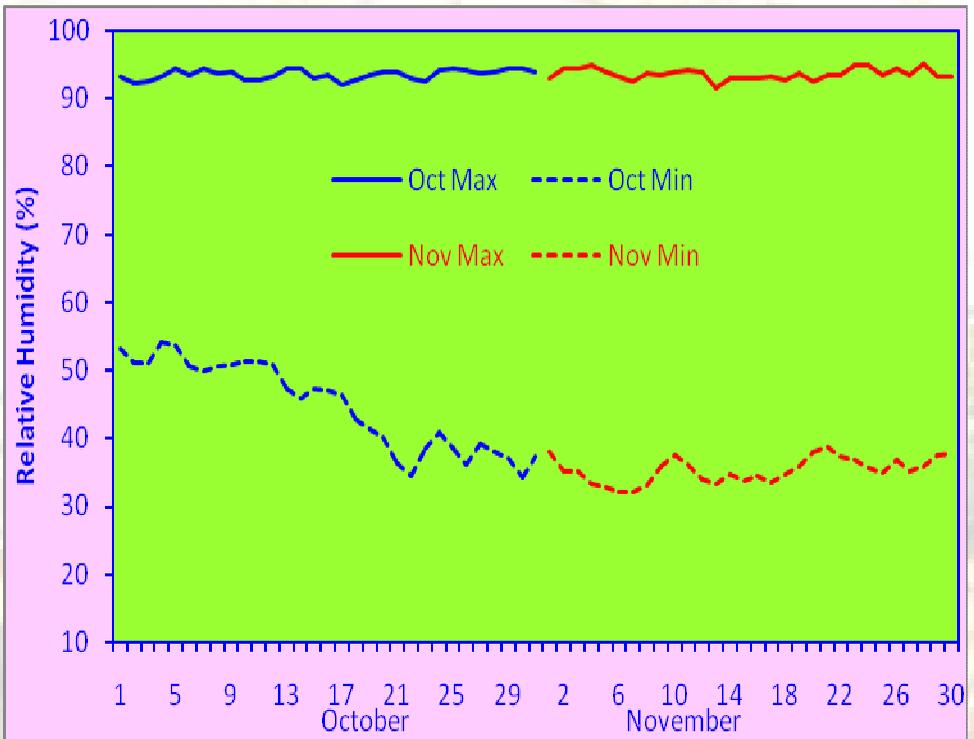


Fig. 53. Normal Maximum and Minimum Relative Humidity during Post Monsoon Season

Diurnal variation of Relative Humidity

The RH has the maxima around 0700 hrs IST and minima around 1500 hrs IST (Fig 54). The steepest fall in RH from morning to noon; and steepest rise from afternoon to night is experienced in this season particularly in November.

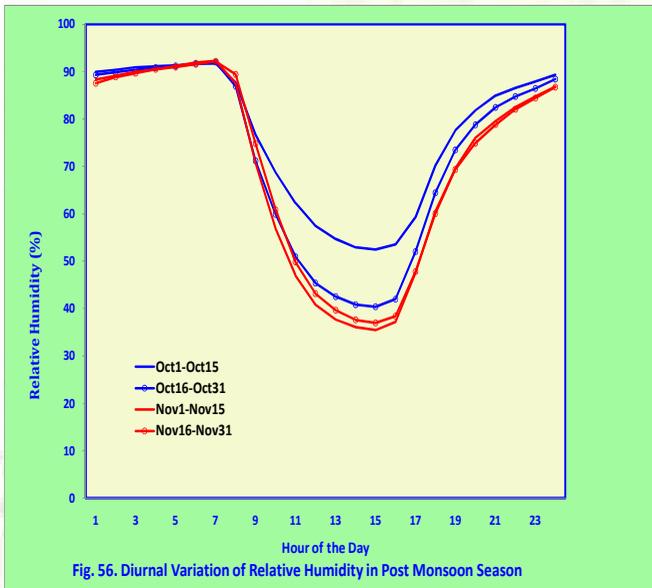


Fig. 56. Diurnal Variation of Relative Humidity in Post Monsoon Season

Fig. 54. Diurnal Variation of Relative Humidity in Post Monsoon Season

Rainfall

Southwest monsoon withdraws from northwest India during the second half of September and withdraws from Lucknow at the end of September and sometimes in the first week of October. However, the season is not completely devoid of rain/thundershower activity as they occur in association of both the eastward moving mid-latitude weather systems and the westward moving tropical disturbances which cause incursion of moisture. Average number of days with rain is 2.5 and 0.9 for the months of October and November, respectively. The daily normal rainfall is around 2.5 mm during the first half of October. (Fig. 55)

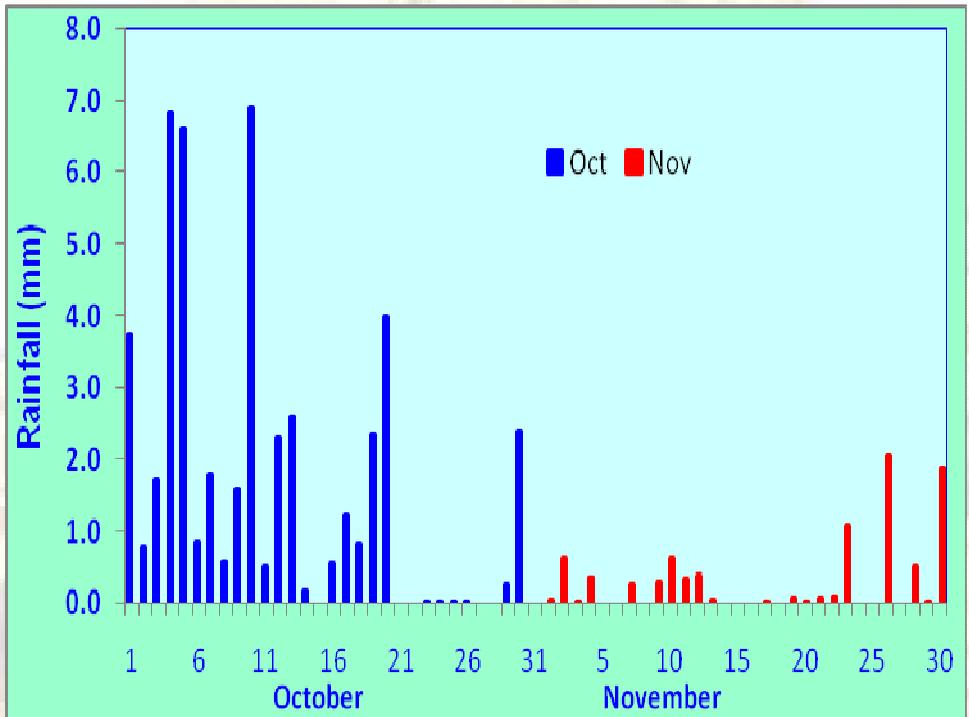


Figure 55 Daily Normal Rainfall for Post Monsoon Season

Subsequently there is a decrease and the normal rainfall is less than 0.5 mm per day on most of the days the average monthly total rainfall is 40.9 mm and 7.4 mm for the months of October and November, respectively.

The probability of rainfall for individual days shows large fluctuations indicating uncertain behavior of rainfall in the season (Figure 56). There is a decrease from 15-25% in the beginning of October to less than 5% in the last week of October and continues to the end of the season except occasional increase of probability to more than 5-10% in the month of November

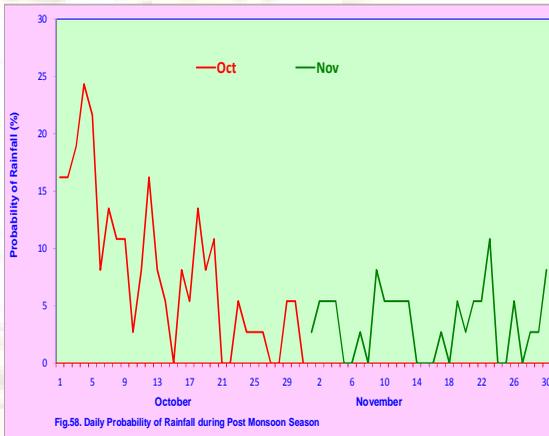


Fig.58. Daily Probability of Rainfall during Post Monsoon Season

Figure 56 Daily Probability of Rainfall during Post Monsoon Season

Heavy Rainfall

Generally, heavy rainfall are not experienced in the season. But on some occasion heavy rainfall occurred in the month of October while retreating the monsoon. The heaviest rainfall of 24 hours during October and November for the period 1971-2010 given in Figure 57 show that it is less than 4 cm in majority of years. During the above 40 years heavy rainfall never occurred in the month of November but on few occasion heavy rain occurred in the month of October. The all time records for heavy rainfall are 199.8 mm for October (10 October, 1985) and 48.2 mm for November (4 November, 1927).

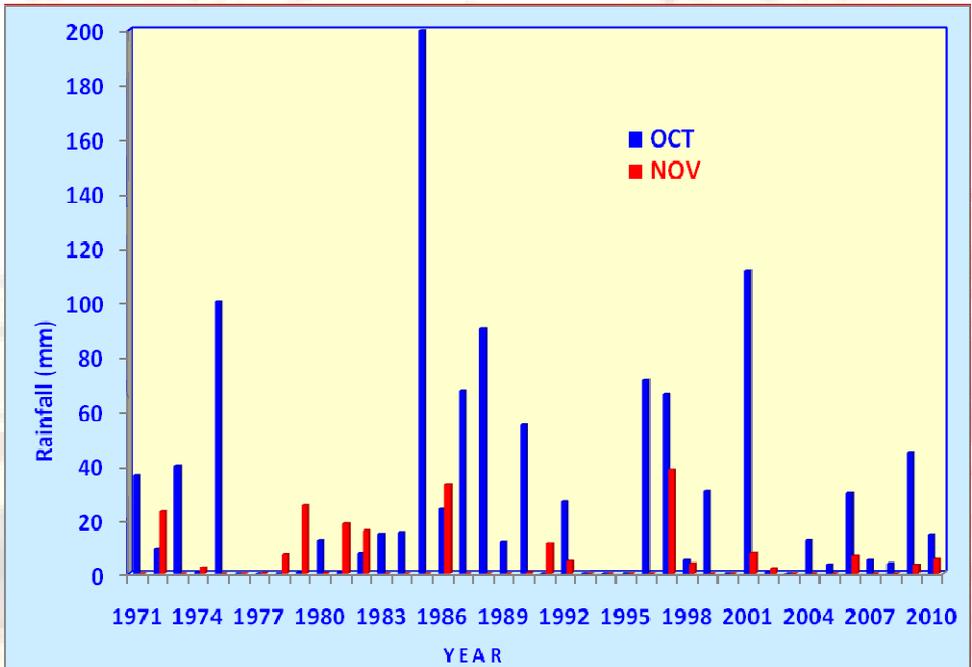


Figure 57. Heaviest 24-hours Rainfall in Post Monsoon Season

Squalls

Occurrence of squalls is almost negligible for the month of November as there was no squall recorded during the period of 30 years (1981-2010). Their occurrence is also very less in the month of October too. Only three squalls were recorded in the month of October during the same period, the strongest being of 70 kmph on 2 October 2009. The most preferred direction for squall is north to north-east as 67 % of the squalls during the October have approached from that direction (Fig. 58.).

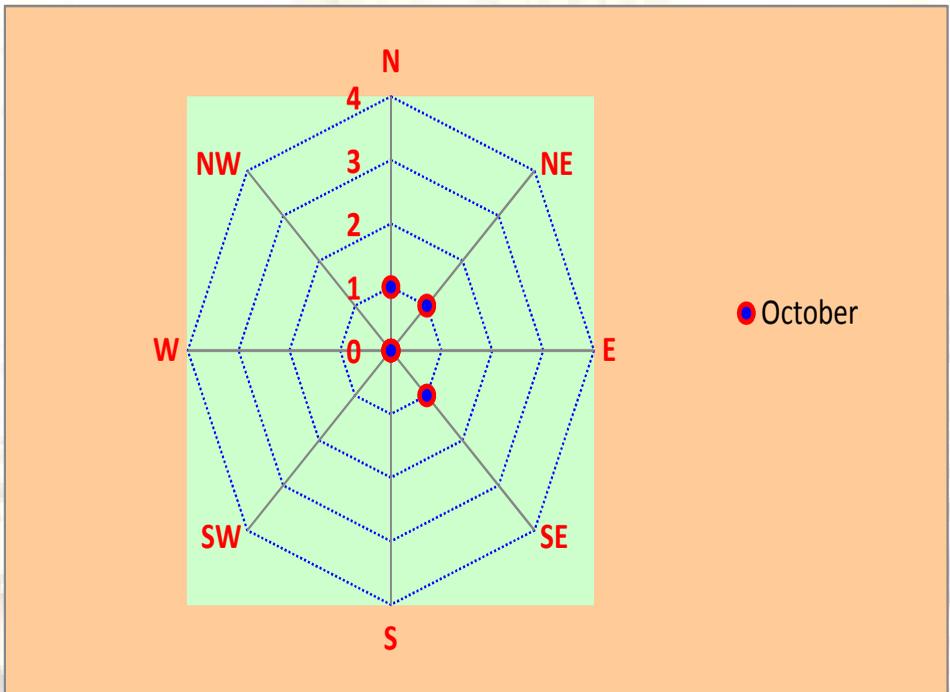


Fig. 58. Frequency of approach of squalls from different directions during October

Thunderstorms and other weather phenomena

As the normal rainfall activity is less, thunderstorm activity is also not very pronounced during the season. The average number of thunderstorms is 1.2 in October and 0.6 in November. The most preferred time for occurrence of thunderstorms is from noon to midnight (0900-1800) in October, during which more than 55 % of the thunderstorms have occurred. The most preferred time in November is 1200 to 1800 IST, during which more than 38% of the thunderstorms have occurred (Fig 59).

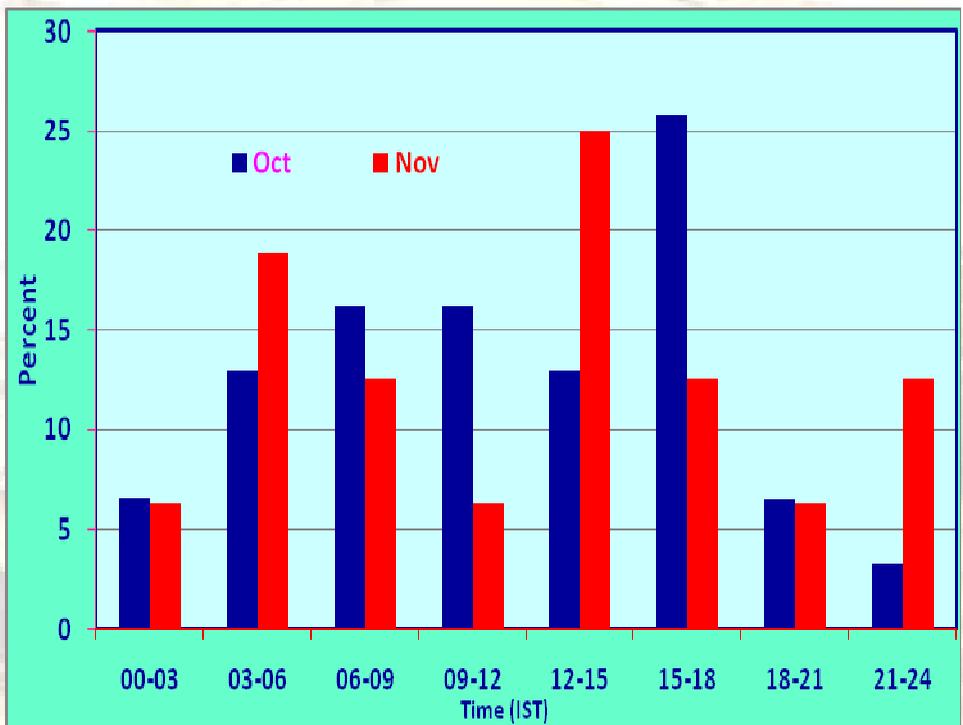


Figure 59. Diurnal variation of thunderstorms during Post Monsoon Season

wind

Winds generally are not very strong during the season. Hourly average wind speeds given in Fig. 60 show that the period from 1800 IST in the evening till 0700 IST next morning has the lightest wind about 2 to 4 kmph. The strongest winds of around 8 to 10 kmph are realized during just after the noon hours (1300-1500 IST). Subsequently, there is a sharp drop till 1800IST. From 1000 IST to 1700 IST. The strongest winds of the season around noon hours are recorded in the second fortnight of November.

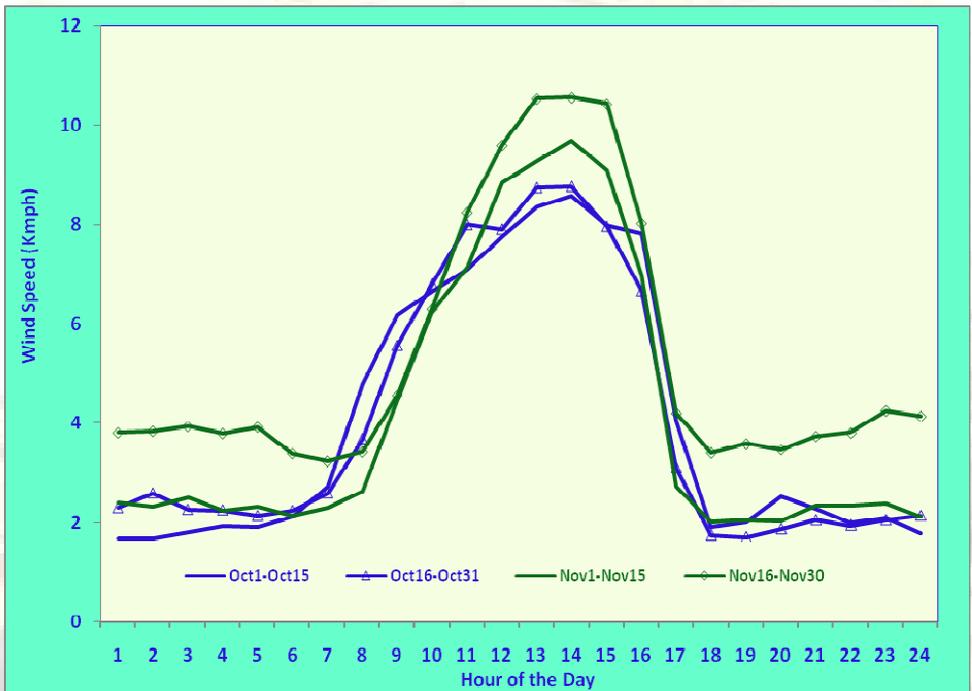
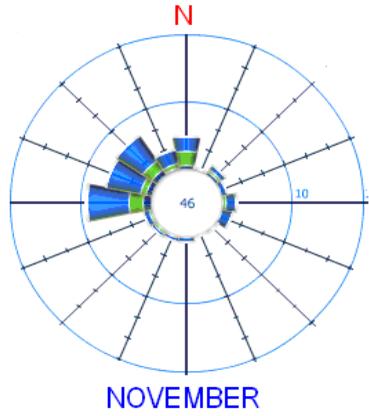
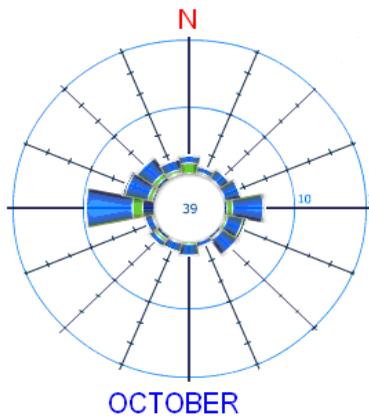
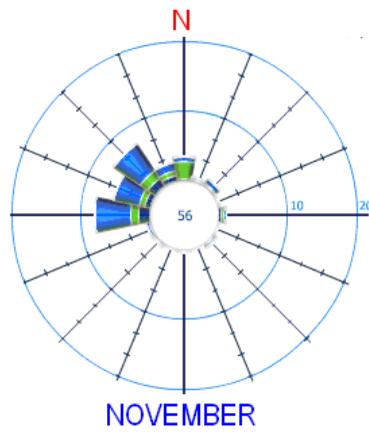
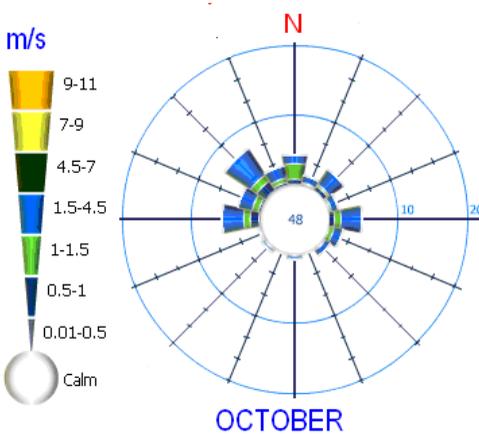


Figure 60 Diurnal Variation of Wind Speed during Post Monsoon Season

As the monsoon withdraws, westerly to northwesterly again becomes the most prominent wind direction (Figure 61). This is the least windy season for Lucknow



Morning



(Evening)

Fig. 61. Wind Roses of the Post-Monsoon Season

Though the average wind speed in the season never reaches 10 kmph, there is a low probability of 35-40% that the wind speed exceeds 10 kmph during 1200-1600IST in the afternoon (Figure. 62.)

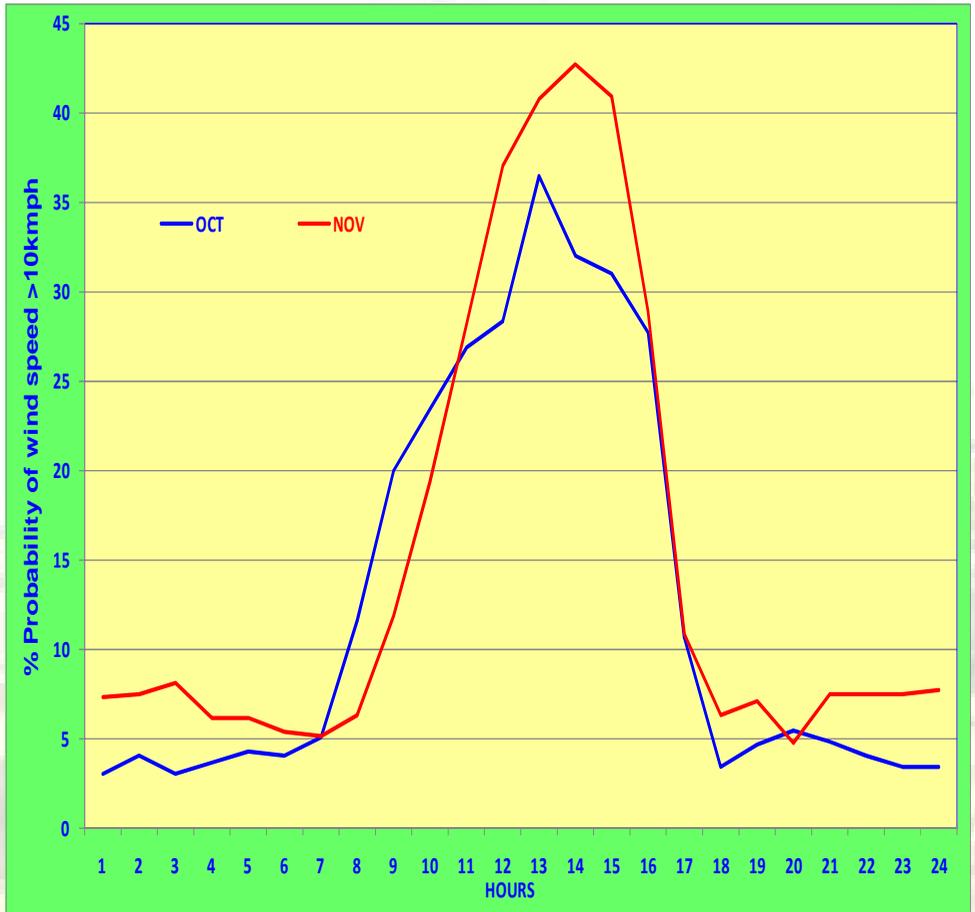


Figure 62 Probability of Wind Speed to exceed 10 kmph during Post Monsoon Season

Weather on National Festival Days

The Independence Day (15 August), Republic Day (26 January) and Gandhi Jayanti (02 October) are the National Festivals of India which are celebrated with great patriotic fervor all over the country. The main functions of the state on these days are held in the State Capital-Lucknow. The general weather conditions of these days are described in the following section.

Independence Day (15th August)

The maximum /minimum temperatures and rainfall on Independence day for the last 40 years (1971-2010) given in Figure 63 show, that during most of the years the maximum temperatures range between 30 and 35°C. However it has been as high as 35.5°C in 1978 and as low as 27.8°C in 1998. The minimum temperatures range between 25-27°C. The lowest minimum temperature recorded during the period has been 23.4°C in 2008 and the highest was 27.3°C in 1991. The probability of rainfall is 45 % as rainfall more than 2.5mm was recorded in 18 years on 15th August out of the last 40 years. The highest rainfall of 143.7 mm was recorded on 15th August, 2010.

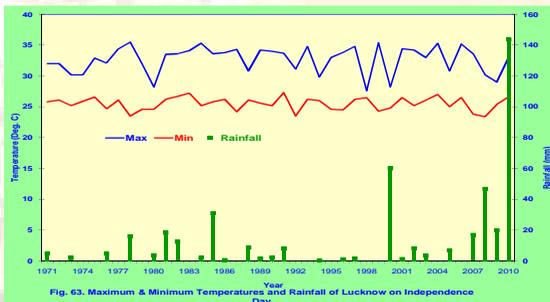
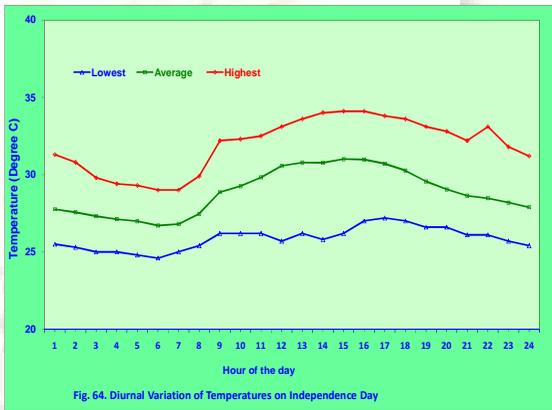


Fig. 63. Maximum & Minimum Temperatures and Rainfall of Lucknow on Independence Day

Diurnal Variation of temperatures on Independence Day

The diurnal variation of temperature on the Independence Day is given in Fig 64. The green line shows the average temperature of different hours of the day. The red and blue lines show the highest and lowest temperatures respectively, recorded at different hours of the day. The average lowest temperature of about 27 °C is recorded around 0600 and 0700 hrs IST in the morning. The temperature increases steadily to 30 °C by 1200 hrs IST. It then remain around 30 to 31 °C till 1700 IST in the evening. It then gradually falls to around 28 °C by midnight. High temperatures in excess of 34°C have also been recorded at 1500 hrs IST on Independence Day. However, pleasantly low temperatures less than 27 °C have been realized all through the Independence Day in the past 40 years.



Republic Day (26th January)

The weather on Republic day is marked by misty and cold mornings and pleasantly warm afternoons. The minimum temperatures during most of the years range between 5 and 10 °C (Figure 65). The lowest minimum temperature during last 40 years 4.4 °C in 2010 and the highest 14.0 in 1982. Incidence of rain is not very common as rainfall has been recorded only on 5 years during last 40 years, with a highest amount of 16.5 mm in 1982. . The maximum temperature are of the order of 20 to 25 °C. Highest maximum temperature during last 40 years 27.9 °C in 1992 and lowest maximum temperature 14.7 °C in 1971. Mist or Fog is the most common weather phenomena of Republic day in Lucknow.

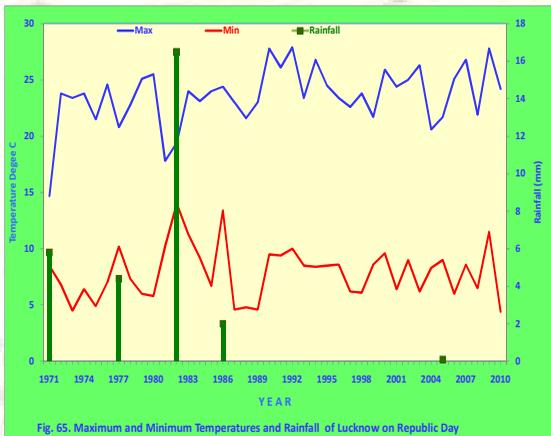
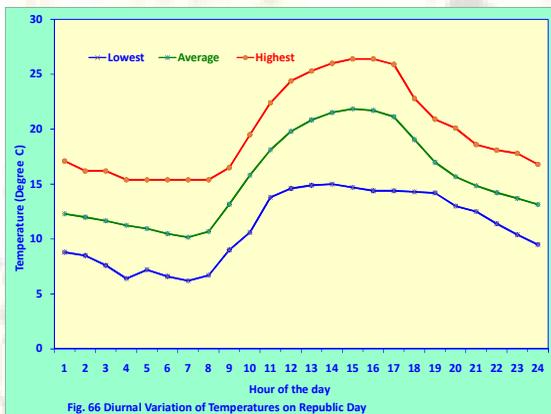


Fig. 65. Maximum and Minimum Temperatures and Rainfall of Lucknow on Republic Day

Diurnal variation of Temperature on Republic Day

The diurnal variation of temperature on the Republic Day is given in Fig 66. The green line shows the average temperature of different hours of the day. The red and blue lines show the highest and lowest temperatures respectively, recorded at different hours of the day. The figure shows that average temperature are around 11 °C till 0800 IST in the morning. The temperatures then increases rapidly to about 20 °C by 1200 IST and further to 22 by 1500 IST in the afternoon. The remain 20-21 °C till 1700 in afternoon. The evening cool down rapidly with temperature falling to 15 °C by 2100 IST and 13 °C by mid-night the Republic day during certain years have been quite mild with temperature reaching to about 17 °C by 0900 IST and in excess of 20 °C from 1100 IST in the forenoon to 2000 IST in the evening. However, quite low temperatures have been recorded in past all through the day.



Gandhi Jayanti

Generally dry weather, pleasant mornings and warm afternoons are main weather characteristics of weather in Lucknow on Gandhi Jayanti. The temperature and rainfall of Gandhi Jayanti Day (Figure 67) shows that the minimum temperatures during most of the last 40 years has ranged between 20 and 25 °C. The lowest minimum temperature recorded during the period was 16.9 °C (1991) and the highest was 27.6 °C (2004). The maximum temperature most of the last 40 years has ranged between 30 and 35 °C. The highest and lowest maximum temperatures realized on Gandhi Jayanti during last 40 years in Lucknow have been 36.8 °C (2006) and 25.6 °C (201), respectively. The reason for this pleasantly low maximum temperature on Gandhi Jayanti was that a rainfall on 11.5 mm was recorded in Lucknow on this day. Otherwise, the incidence of rainfall on this day is not very common in Lucknow. During last 40 years there have been five more days when rainfall was recorded in the city. (Figure 67).

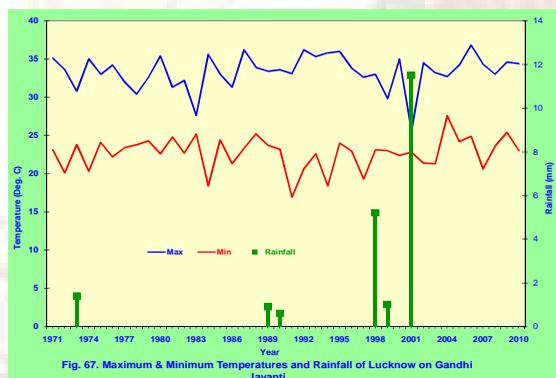


Fig. 67. Maximum & Minimum Temperatures and Rainfall of Lucknow on Gandhi Jayanti

Diurnal variation of Temperature on Gandhi Jayanti

The diurnal variation of temperature on the Gandhi Jayanti is given in Fig 68. The green line shows the average temperature of different hours of the day. The red and blue lines show the highest and lowest temperatures respectively, recorded at different hours of the day. The figure shows that lowest average temperature of about 24 °C are recorded from 0400 hrs to 0700 hrs in the morning. The temperatures then increases rapidly to about 30 °C by 1100 IST. It the further rises and remain about 31 °C from 1200 hrs to 1700 hrs in the afternoon. The evening cools down slowly with temperature falling to 25 °C by mid-night.

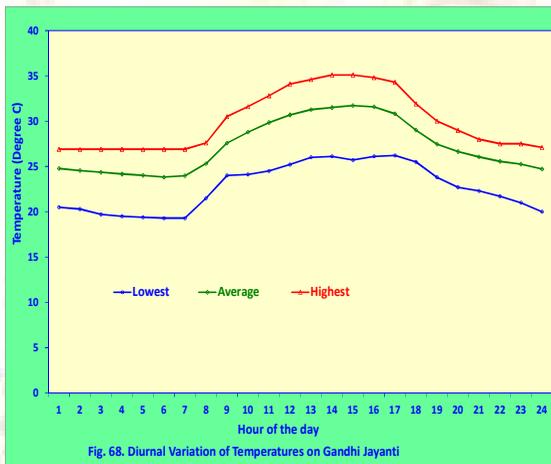


Table 1: Average and Extremes of Temperature over Lucknow

Month	Maximum Temperature (°C)			Minimum Temperature (°C)		
	Mean	Highest ever	Date and Year	Mean	Lowest ever	Date and Year
January	22.5	31.6	1, 1992	7.5	-1.0	31, 1964
February	25.8	34.2	27, 1989	9.8	0.0	2, 1964
March	32.0	40.9	31, 1973	14.5	5.4	10, 1979
April	38.0	45.0	30, 1999	20.5	10.9	1, 1968
May	40.0	46.5	31, 1995	24.6	17.0	3, 1987
June	38.4	47.7	9, 1966	26.7	19.7	12, 1979
July	33.9	44.2	6, 1982	26.0	21.7	1, 1950
August	33.2	40.4	3, 1972	25.6	22.2	23, 1996
September	33.1	40.1	18, 1958	24.1	17.2	29, 1950
October	32.8	38.0	15, 1999	19.1	10.0	31, 1984
November	29.2	38.0	8, 1963	12.8	3.9	29, 1952
December	24.6	29.9	4, 1976	8.4	0.5	30, 1973
Annual	32.0	47.7	9, 1966	18.3	-1.0	31, 1964

Table 2: Average and maximum number of days with cold wave / Heat wave in Lucknow

Month	Average Number of days with		Maximum number of days with cold wave / Severe cold Wave	
	Cold wave	Severe Cold wave	Number	Year
December	1.4	0.1	10	1976
January	2.1	0.0	11	1977
February	0.8	0.3	7	1972

Month	Average Number of days with		Maximum number of days with heat wave / Severe heat Wave	
	Heat wave	Severe Heat wave	Number	Year
April	0.6	0.0	6	1999, 2010
May	0.6	0.0	3	1972, 1975
June	1.4	0.2	8	1972, 1987

Table 3: Average and Extremes of Rainfall over Lucknow

Month	Monthly Total (mm)	Heaviest in 24 Hours		Total in wettest month	
		Rainfall (mm)	Date & Year	Rainfall (mm)	Year
January	20.2	85.0	2, 1980	93.8	1996
February	16.0	46.7	1, 1982	61.3	1970
March	10.0	42.5	25, 1982	62.0	1982
April	5.0	19.6	1, 1965	36.2	1965
May	18.4	57.0	28, 1959	114.5	2000
June	122.9	162.4	26, 1971	412.0	1975
July	269.9	272.4	9, 1960	761.7	1960
August	255.3	250.0	30, 2000	654.2	1967
September	211.5	177.1	14, 1985	698.2	1985
October	40.9	199.8	10, 1985	345.6	1985
November	7.4	38.5	26, 1997	61.2	1997
December	12.6	49.2	09, 1997	95.9	1997
Annual	990.1	272.4	9 July, 1960	2143.0	1980

Table 4. Average number of days with different weather Phenomena

Month	Rain	Hail	Thunder	Squall	Dust Storm	Fog
Jan	2.2	0.0	0.9	0.0	0.1	9.1
Feb	2.8	0.1	2.2	0.0	0.1	2.2
Mar	2.1	0.1	2.0	0.0	0.3	0.1
Apr	1.6	0.1	2.0	0.4	2.2	0.1
May	2.9	0.1	4.2	0.0	2.5	0.0
Jun	7.2	0.0	6.4	0.1	1.3	0.0
Jul	16.8	0.1	10.7	0.2	0.3	0.0
Aug	16.2	0.1	9.5	0.1	0.1	0.1
Sep	11.7	0.1	6.7	0.1	0.2	0.4
Oct	2.5	0.0	1.2	0.2	0.1	0.6
Nov	0.9	0.0	0.6	0.0	0.0	2.0
Dec	1.4	0.0	0.6	0.0	0.4	8.5

Table 5.Highest magnitude of fall in temperatures (°C) in 24 hours in winter Season

Month	Maximum Temperature		Minimum Temperature	
	Temperature Fall	Date, Year	Temperature Fall	Date, Year
Dec	9.5	19, 2008	7.9	10, 1976
Jan	11.5	2, 1992	8.9	2,1992
Feb	8.5	4, 2001	9.2	14,1972

Table 6.Highest magnitude of rise in temperatures (°C) in 24 hours in summer Season

Month	Maximum Temperature		Minimum Temperature	
	Temperature Rise	Date, Year	Temperature Rise	Date, Year
Mar	6.6	24, 1991	7.7	10, 1978
		21, 1996		17,1999
Apr	6.0	19, 1983	6.4	14, 1983
May	7.3	23, 2003	6.0	24, 1972
Jun	6.8	20, 2004	5.5	15, 1986

Table 7.Highest magnitude of fall in temperatures (°C) in 24 hours in summer Season

Month	Maximum Temperature		Minimum Temperature	
	Temperature fall	Date, Year	Temperature fall	Date, Year
Mar	13.5	10, 2006	7.6	22, 1983
Apr	9.5	18, 2006	7.5	29, 2006
May	8.7	14, 1987	6.7	17, 1997
Jun	10.8	13, 2007	7.6	23, 2005 06, 2009

Criteria for Heat Wave and Cold wave

Heat Wave

a) When normal maximum temperature of a station is less than or equal to 40° C

Heat Wave : Departure from normal is 5° C to 6° C

Severe Heat Wave : Departure from normal is 7° C or more

b) When normal maximum temperature of a station is more than 40° C

Heat Wave: Departure from normal is 4° C to 5° C

Severe Heat Wave: Departure from normal is 6° C or more

c) When actual maximum temperature remains 45°C or more irrespective of normal maximum temperature, heat wave should be declared.

Note: Heat wave need not be considered till maximum temperature of a station reaches atleast 40° C for Plains and at least 30° C for Hilly regions.

Cold wave

Wind chill factor plays an important role and brings down the actual minimum temperature depending upon the wind speed. The actual minimum temperature of a station is reduced to 'WCTn' as per WMO technical note No. 123.

For declaring 'Cold Wave' WCTn is used. If WCTn is 10 Deg.C or less, then only the conditions for cold wave should be considered.

a) When normal minimum temperature is equal to 10°C or more.

Cold Wave: Departure from normal is -5°C to -6°C.

Severe Cold Wave: Departure from normal is -7°C or less

b) When normal minimum temperature is less than 10°C.

Cold Wave: Departure from normal is -4°C to -5°C.

Severe Cold Wave: Departure from normal is -6°C or less.

When Wind chill effective minimum temperature (WCTn) is 0°C or less, Cold Wave should be declared irrespective of normal minimum temperature of the station. However, this criterion is not applicable for those stations whose normal minimum temperature is below 0°C.